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Higher Education and R&D: India in Global comparative context

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By

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Abstract

India's aspiration of a Viksit Bharat by 2047 rests on the productivity of its young population, and therefore on the strength of its higher education and research systems. This paper places India's tertiary education and R&D in an international comparative frame, benchmarking each indicator against the value expected at India's per capita GDP (PPP) through cross-country regressions, and measuring the gap from that benchmark for India and its comparators. India's tertiary gross enrolment ratio, at 33.1%, is close to its benchmark, and the adult share with a bachelor's degree, at 13.2%, marginally above it; the master's share falls short. Scale compensates for rates: with 105–108 million bachelor's degree holders, India's tertiary educated adult population is second only to China's. Employability of the credentialed has risen from 47.3% to 56.4% since 2019, but remains sharply stratified between professional institutions, universities and vocational institutes. R&D presents a mixed picture, with expenditure above the benchmark for India's income level, while researcher and technician density falls well below it. Keeping pace with projected per capita income growth requires a tertiary GER of 40.7% by 2030 and 61.7% by 2050, and a near tripling of researcher density.

[1] Dr Arvind Virmani is Member, NITI Aayog. Author acknowledges the dedicated work of Jasleen Sharma, Junior Research Assistant in the office of Member(av), in collecting & processing the data, material & references. Any views expressed in the paper are those of the Author and should not be attributed to NITI Aayog or GOI.

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1. Introduction

In the context of India's goal of sustained, fast, inclusive growth to achieve a Viksit Bharat, education and skilling are critical for employment and wage growth. Education builds human capital which has been recognized as an important complement to Physical Capital. Education implies learning, and only learning outcomes matter for subsequent acquisition of job skills and productive employment. Education cannot be measured by the certificates issued for primary school, lower secondary school and upper secondary school, if they merely indicate the number of years spent in school, if the majority of students don't have minimum proficiency in Reading and Arithmetic. Such certificates do not necessarily create human capital.

As India aims to become a developed country by 2047 under the PM's vision of "Viksit Bharat", improving the productivity of its young population is essential.[2] While access to education has expanded, learning outcomes remain weak. There is a gap between the credential or degree and the learning expected of students with those qualifications. There is also a gap between what is learned in school & college and the basic requirement of jobs; many students

[2] Reference is to labor productivity and the role of education & job skills in enhancing it.

earn degrees but lack the job skills needed to secure matching jobs. As a result, formal education alone does not guarantee better wages or economic mobility.

Section 2 provides a framework within which the education & skilling system is analyzed. Section 3 covers tertiary education, with a focus on enrollment, completion, and the quality of skills training in relation to employability. Section 5 focuses on adult education, particularly the size and scalability of India's educated labor force in comparative perspective. Section 6 examines research and innovation through indicators such as doctoral completions, R&D expenditure, researcher and technician density, firm-level investments, innovation outputs, and patent activity. Section 7 concludes the paper.

The benchmark used in this paper are generally a function of per capita GDP. Absolute numbers of educated and skilled population, labor and work force is relevant when we defining comparative advantage relative to both our comparator countries and vis-à-vis other countries. Future comparative advantage depends on the relative numbers of school & university educated being graduated from its schools & colleges respectively. Even with India's school completion rates lower than higher income comparator countries, the comparative numbers are higher than China's and often exceed it. The number of children completing primary education in India (137 mil) were 1.25 times those in China and more than 2.5 times the combined total of Vietnam, Indonesia, Thailand and Mexico (MIC4). The number of children completing lower secondary school (65 mil) were 1.2 times those of China. The number of children completing upper secondary school (98 mil) were also 1.2 times those China and 3.7 times those of the MIC4 (Vietnam, Indonesia, Thailand & Mexico) combined. The number of students enrolled in tertiary education (52 mil) was more than double those of the four comparators combined.

The current stock of adults with different levels of education, also compares well with relevant comparator countries. Broadly India has a larger number of adults with Tertiary education (Bachelors & Masters) than China, while China has a higher number of adults with primary & secondary education; India's adult population with bachelor's degree was 1.4 times China's, while its adults with secondary education were 0.85 China's. India's stock of adults with primary, lower and upper secondary education was 1.8 to 2 times the corresponding numbers for MIC4 (combined).

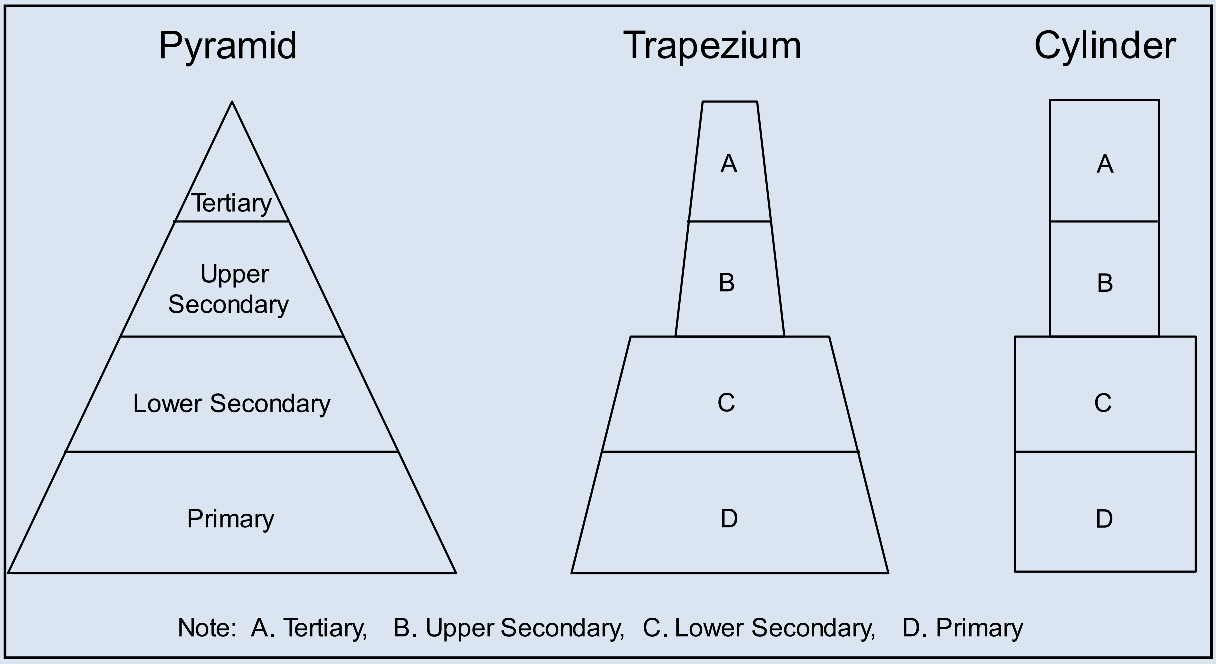
2. Framework and Methodology

The development of Indian education was framed by the constitution. Education including Universities was entry No. 11, in List II (State list) of the constitution. The 42nd amendment of the constitution in 1976, effective January 1977, deleted this entry and inserted Education as entry 25, in list II (concurrent list) of the constitution. Parliament obtained the right to set All India norms, while all other rights remained with the States as long as they do not collide with union law (Art 254). Entries 63-65, List I (Union list) in which Parliament had the right to declare institutions of National importance, establish agencies for specialist training & research, and legislate academic standards in institutions of higher education and research, continued unchanged.

This meant that Primary and Secondary education (primary, middle and high school) was the sole responsibility (and right) of the States, from independence in 1947 to 1976, when education was moved to the concurrent list of the constitution. Thus for 30 years, Indian States had the complete and full responsibility to provide education to its residents and the national result in primary & secondary education, were a mere aggregation of different results obtained by States each with own goals and priorities. The constitutional position was therefore one of decentralization, similar to the USA in some ways, but very different in others.

The USA had an even more decentralized system for education than India, with local authorities playing a big role in primary and secondary education, financed by local taxes. USA successfully built a *pyramidal system* of education, with a wide base, a narrower middle and a highly effective and efficient high end (Error! Reference source not found.**,** left panel). At the other end of the development policy spectrum, the USSR, with a very centralized national education system, also created a pyramidal structure of education, but with a much narrower middle than the USA.[3]

Figure 1: Education structures: Pyramid, Trapezium and Cylinder



In contrast to both USA and USSR, India created a *cylindrical structure* of education in the early decades (right end of **Error! Reference source not found.**). This was partly due to the constitutional division of responsibilities, in which National government had a substantial role in higher education, but States had absolute authority and control over primary and secondary education for four-five decades. The adult literacy rate was 40.8%, and youth literacy rate was 53.8% in 1981, despite the shift of Education from the State list to the Concurrent list of the constitution in 1977. The adult population with "lower secondary" education, was 16.2% of all adults 25 years old & over (1981). The low youth literacy rate reflected the primary school enrolment rate of 61% in 1971 (**Error! Reference source not found.**).

The USA's success in Primary and secondary education was driven by local Govts and communities. They created the Govt (public) education system, using local taxes to create universal access to Primary education by 1910 and near universal secondary education (~73%)

[3] Like Eiffel tower

by 1940, from ~19% in 1910 and ~50% in 1930. At the State level India's education system, with Primary & secondary education centralized in the State capitals, with no decentralization to local rural and urban levels, was more akin to the USSR's centralized national system. USSR raised the primary enrolment rate from 40% in 1914 (Tzarist Russia) to 60% in 1928 (post revolution recovery) to 95% in 1932.[4] India in contrast had a primary enrolment rate of 79.5%, and a primary completion rate of 75.3% in 2000, 50 years after independence. India did not have universal primary education, and its secondary school gross enrolment rate of 47.2% (2000), was half way between that of the USA and USSR in their education system development phase (1930-1940).

Table 1: Education Indicators: 1971, 1981, 2000, 2011 and 2018

Education Indicator (% of relevant group)	1971	1981	2000	2011	2018
Adult Literacy (% of pop 15+)		40.8	61.0	69.3	73.7
Youth literacy (% of pop 15-24)		53.8	76.4	86.1	94.6
Primary education, pop25+ (%)			39.0	51.4	59.6
Lower Secondary education, pop25+ (%)	5.0	16.2		37.6	46.1
Upper Secondary education, pop25+ (%)			9.8	26.9	32.3
Bachelor Education, pop25+ (%)				9.1	10.8
School enrollment, primary (% net)	61.0		79.5	90.4	
Primary completion rate, (% of relevant age)			75.3	93.3	
School enrollment, secondary (% gross)			47.2	67.1	76.0
School enrollment, secondary (% net)					
Lower Sec Completion, (% of relevant age)				77.4	
School enrollment, tertiary (% gross)			9.9	23.3	28.4

Data source: World Development Indicators, December 2025. Historical data is available for selected years for each variable.

USA's private sector (including endowments and trusts) was welcomed and encouraged to play a role in USA's highly successful higher education system, Indian Courts have historically restricted private for-profit education.[5] The USSR succeeded in creating a highly educated (STEM) industrial workforce and in achieving specific technological milestones, especially in defense and space.[6] India can learn much from the experience of USA's highly successful

[4] USSR was much less successful in raising the secondary enrolment rate which was 15-18% in 1930 and ~21% in 1940, with only10-15% completing secondary School.
[5] In *Unni Krishnan v. State of Andhra Pradesh* (1993), the Supreme Court ruled that education is a fundamental right under Article 21 but cannot be commercialized or treated as a business for profit, prohibiting "profiteering" while allowing only reasonable surplus for expansion. In T.M.A. Pai Foundation v. State of Karnataka (2002), it reinforced this by permitting private unaided institutions autonomy but mandating they avoid profit motives, aligning with Article 30 (minority rights) and public policy against education as trade.
[6] The state provided Universal Access at the Base, rigorous Selection for Advancement, Structured Academic and Career Ladder, and Elite Institutions at the Top. Competitive exams and specialized tracks (such as physics-maths schools and Olympiads) enabled academically gifted students to rise through the system. Advancement through institutional hierarchies provided structured mobility for those who met performance standards.

higher education system, but the USSR and PRC experience is also relevant, because much of India's higher education and R&D system is still administered by Government.

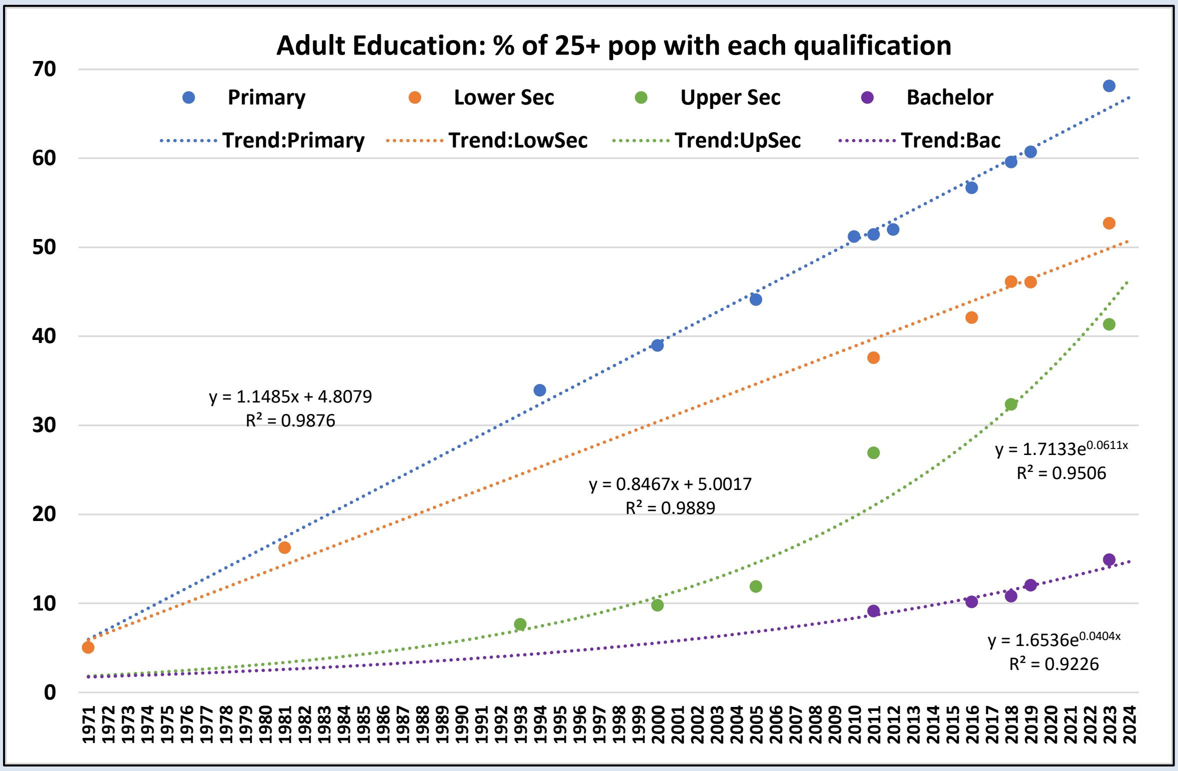
Error! Reference source not found. illustrates the evolution of India's education system from a cylindrical structure through a Trapezoid to a Pyramid, based on regression equations for adult education, shown in **Error! Reference source not found.**. **Error! Reference source not found.** uses available data on adult qualifications (primary, lower secondary, upper secondary and Bachelor) in different years to run an intertemporal regression. The best fitting equations are then used to interpolate & extrapolate the data (upper panel of **Error! Reference source not found.**).

Table 2: Projection of Adults age 25+ with different Qualifications based

	1971	1981	1991	2000	2011	2019
Qualification	***Estimated Value based on regression***					
Bachelor Degree	1.7	2.6	3.9	5.6	8.7	12.0
Upper Secondary	1.8	4.9	5.8	10.8	22.4	34.7
Lower Secondary	5.8	14.3	22.8	30.4	39.7	46.5
Primary	6.0	17.4	28.9	39.3	51.9	61.1
	Ratio of estimated value to Primary					
Bachelor Degree	0.29	0.15	0.13	0.14	0.17	0.20
Upper Secondary	0.31	0.28	0.20	0.27	0.43	0.57
Lower Secondary	0.98	0.82	0.79	0.77	0.77	0.76
Primary	1.00	1.00	1.00	1.00	1.00	1.00

Source WDI, Dec 2025.Authors calculations based on intertemporal regressions in fig 2.

Figure 2: Long term trend in Adult Education (% of 25+ pop with each qualification)



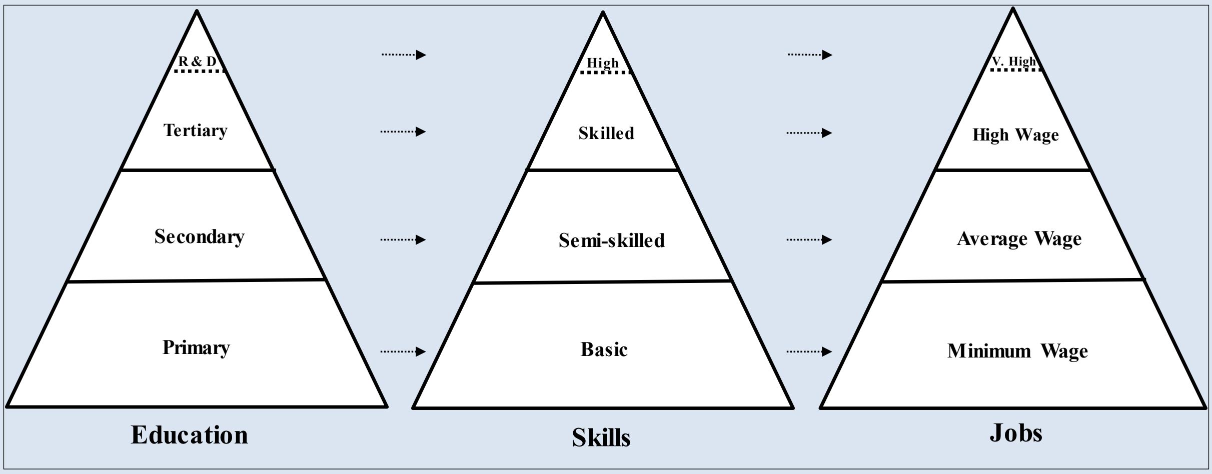
Source WDI, Dec 2025. Lines represent intertemporal regressions. Equation & R^2 are shown.

In 1971 the structure was a double cylinder (**Error! Reference source not found.**, right panel), with the ratio of Bachelors to Primary and Upper secondary/primary an estimated 0.31 and 0.29 respectively, with lower secondary/primary at 0.98 (rows 7, 8 & 9, **Error! Reference source not found.**).[7] By 1981 these ratios had become 0.15 for bachelors/primary and 0.28 for upper secondary/primary, transitioning to a double trapezoidal structure (**Error! Reference source not found.**, middle panel). Pyramidal structure began to emerge during 2000-2011 with Bachelor/primary ration of 0.14, upper secondary/primary ratio of 0.27 and lower secondary/primary ratio of 0.77 in 2000 and ratios of 0.17, 0.43 and 0.77 respectively in 2011 (**Error! Reference source not found.**, lower panel).

As we survey the human capital eco-system in India today, education, job skills and employment opportunities can be viewed as three pyramids. The education pyramid is built on a base of primary education, with secondary education in the middle and tertiary education at the top and researchers at its pinnacle or tip. Similarly, the Skills pyramid is built on basic/low skills, with "semi-skilled" in the middle, and skilled on top (**Error! Reference source not found.**).

[7] Literally a cylinder on top of a trapezium.

Figure 3: Education, Skill, and Job Pyramids: Interlinking challenge



The education and skill pyramids cannot grow if either the foundations are weak or the connectivity between education and job skills at each level, is poor. Finally, the job pyramid consists of minimum/low wage, Average/medium wage and high wage employment (figure 3). Each level of the employment pyramid must be linked to the appropriate levels of the skill pyramid and the education pyramids to generate the most productive employment, on average. Real wage growth within each layer, also depends on "on-the-job training" and "learning by doing," and movement between layers on upskilling and re-education.

The connectivity between the Tertiary level of education, skilled persons and High wage jobs is far better than for semi-skilled worker and individuals with primary education or less. The demand from large firms creates profitable opportunities for private placement agencies and skill providers. The semi-skilled (medium skills) level is less profitable but much more important in India than in other middle-income countries (MICs). Self-employed workers constitute 57.7% of all workers, of which about 11.8% are professionals. Thus 45.9% of them need sound secondary education and training in semi-skilled occupations. As regular salary and wage employment constitutes only 23.2 per cent of the labor force, while 19 % are casual labor, the latter need better primary education and basic skills to operate efficiently in a modern economy. Labor market linkages in the informal sector are either weak or non-existent, and even within the formal sector, the efficiency of job matching mechanisms varies across semi-skilled and skilled occupations.

The above framework seems to underly the National Education Policy, given that Vocational education and Training was covered by it, and the emphasis NEP placed on training & activities outside the boundaries of the conventional, formal academic curriculum. It is therefore necessary to understand the goals and suggestions of NEP (2020), before placing Indian education and skilling system in an international comparative framework.

2.1 Methodology: International Comparison

The paper includes numerous international comparisons using data from World Bank, World Development Indicators (WDI). A common methodology is followed in this comparison. For each indicator (Y), the data is collected for all countries (i) and for the latest available year (t); e.g., enrolment rates, completion rates, literacy rate, proportion of population with primary education. For each country the Per capita GDP at PPP in constant 2021 international prices, is collected for the same year (X_{it}), to create matched pairs of the indicator and PCGDP for same year. Most social indicators (Y) are positively correlated to Per Capita GDP (X), i.e., Y = f(X).[8] Assuming a polynomial function, this can be written as,

$$Y = A + B\,X + C\,X^2, \tag{1}$$

And the estimation equation is,

$$Y_{it} = A + B\,X_{it} + C\,X_{it}^2 + E_{it}, \text{ where } E_{it} \text{ is the error term, t is the year, } i = 1 \ldots\ldots\ldots\ldots N \tag{2}$$

The cross-country regression for the latest available year t, yields estimate of A, B and C. Using the estimates, we can calculate the "expected value" of the indicator (Y_o) for any specific value of PcGDP (X_o), as

$$Y_o = A + B\,X_o + C\,X_o^2 \tag{3}$$

The Gap between the actual value of the indicator and the expected value, can be calculated using equation (2), as

$$GAP_i = E_i = Y_i - (A + B\,X_o + C\,X_o^2) \tag{4}$$

These can also be depicted on an XY graph, with a regression trend line through the data points. This line represents the "expected value" of the indicator at each level of Per capita GDP at PPP. The GAP is the vertical distance between the data point and the line, with points above the line having a positive gap and those below the line having a negative gap.

In this paper we also use two key threshold levels for PcGDP PPP in 2021 international dollars: One is \$12,800 (X_1), the PcGDP PPP of Indonesia after it became an Upper middle country (UMIC) in 2019, and the second is \$37,000 (X_2), the PcGDP PPP (2021) of Romania when it became a High-Income country (HIC) in 2019. By inserting these in the right side of equation (3) in place of X, we can calculate the values of the indicators as Y_1 and Y_2, respectively. These are used as minimum benchmarks for a lower income country like India, aspiring to become a UMIC or HIC.

The latest year for which data is available for a country (j) is sometimes very old (e.g., 2013), relative to that of most countries (generally 2023). In this case we estimate a value for the indicator for the country j by assuming the GAP_j (2013) which prevailed in 2013, remains unchanged till 2023, when the PCGDP is X_3. The estimated value of indicator is as follows,

$$Y_j\,(2023) = GAP_j\,(2013) + (A + B\,X_{j3} + C\,X_{j3}^2), \text{ where } X_{j3} = \text{PCGDP-PPP}_j\,(2023) \tag{5}$$

The paper also uses a baseline projection of India's PCGDP PPP to determine when it will cross the above mentioned UMIC & HIC thresholds of per capita GDP PPP of \$12,800 and \$37,000 respectively. PCGDP projection used in this paper, is based on an average growth of PCGDP PPP (const 2021 Int\$), of 6.4% in current decade, 5.4% in next decade and 4.4% in third decade, with an overall three-decade average of ~5.5%. In this base case, India will cross the UMIC PCGDP PPP threshold of \$12,800 around 2030 and the HIC threshold of \$37,000 around 2050

[8] In this illustration we use a polynomial functional form. In the paper we have also used linear, log and exponential functions.

[Virmani (2024)]. If growth rates are higher than this base case, then every education and job skilling challenge outlined in this paper, will be even tougher than stated in the paper.

3. Legacy of State Efforts

75 years have passed since independence the literacy and education levels of the population today are the outcome of policies pursued by the State Govts and (to a lesser extent) by the Central Government programs to nudge the States to improve the education system. This section analyses the results of 75 years of adult education in terms of literacy (sec 4.1) and qualification of the population (section 4.2). The position of India is also compared with other countries with varying per capita GDP, to see where we stand and what improvements are needed in our quest to become Viksit/Developed. The failure of most States to build the base of the education pyramid during the first 30 years of independence, and the slow acceleration by many States during next 20 years, is reflected in the shortfalls we see in the education attainments of the adult population today.

In 2023, 3.1% of population (25+) had Master's degree or equivalent, 14.9% had Bachelor's degree or equivalent and 41.3% had passed secondary school (**Error! Reference source not found.**). The detailed breakdown for tertiary short cycle courses, Bachelor's degrees and Masters degrees is not, however, available for the same years, in the World Bank data set. However, the available data suggests that increase in population of those with Bachelor's degrees or equivalent, is higher than the average increase in tertiary education, while increase in per cent with short cycle courses is about average and the acquisition of master's degrees is much lower.

Table 3: Improvement in Educational Attainment Rate (%)

Education Indicators	**Latest available year**		**Year for comparison**		***Change***
Educational attainment, total (%)		Rates		Rates	
Primary	2023	68.1	2016	56.7	11.4
Lower secondary	2023	52.7	2011	37.6	15.1
Upper secondary	2023	41.3	2011	26.9	14.5
Post-secondary	2023	16.1	2011	10.0	6.1
Short-cycle tertiary	2012	8.9	2005	6.4	2.5
Bachelor's or equivalent	2023	14.9	2018	10.8	4.1
Master's or equivalent	2023	3.1	2018	2.4	0.7

Source: World Development Indicators, July 2025.

4. Tertiary Education

4.1 Introduction

According to AISHE (2021-22), India had 1,168 universities, of which 423 were State Public Universities (37%), 53 were Central Universities and 153 were Institutes of National Importance. Private universities account for 34% of total, with 391 State Private Universities and 81 Private Deemed Universities. 56% of universities specialized in general programs and

16.5% in technical programs. The remaining universities offer medical (6.8%), agriculture (4.6%), science (2.8%), law (2.3%), and management (2.0%) programs.

There are 47,845 colleges in India of which 21.5% are Government colleges, with 34.8% of total enrolment. Private aided colleges account for 13.3% of colleges and 20.6% of enrolment, while private unaided colleges are 65.3% of colleges and 44.6% of enrolment. Colleges are also concentrated on general education (59.5%), followed by teacher education (8.7%), engineering & technology (7.0%), nursing (4.3%), arts (2.7%).

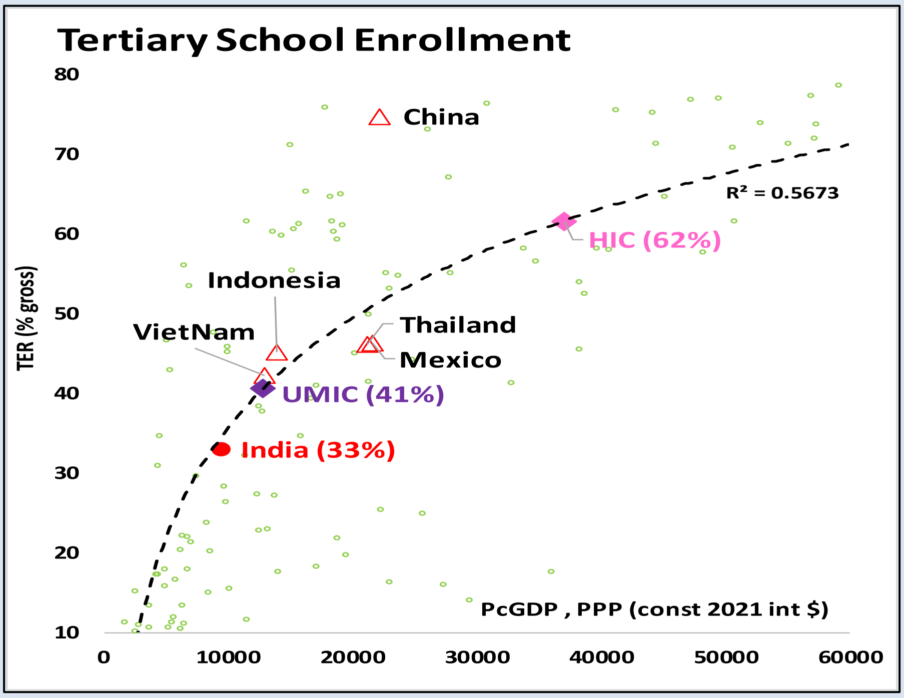
Standalone institutions are evenly distributed across polytechnics (32%), nursing institutions (30%), and teacher training institutes (28%). Other institutes include Paramedical (6%), PGDM (3%), and institutes under ministries (1%).

In this section, we compare India's tertiary education, such as enrollment, and share of adult population with bachelor's and master's degrees. To add to Human capital and factor productivity, this education must generate skills which are needed by industry and services. So, we also look at the employability of the credentialed. The section concludes with a review of Programs and Initiatives aimed at improving access, quality, and employability outcomes in higher education.

4.2 Tertiary School Enrollment

This sub-section presents India's tertiary (college, university) gross enrolment ratio (GER) in an international comparative framework. India's GER for tertiary education was 33.1% in 2023 (**Figure 4**) marginally below the expected/benchmark level at its per capita GDP of 2023. This is a commendable achievement. Thailand (-4.4%) and Mexico (-4.7%) are below the expected level for their respective Per capita GDP levels. However, Vietnam (+1.4), Indonesia (+2.9) performed somewhat better than their benchmark while China exceeded the level expected at its per capita GDP by +23.3 per cent points.

Figure 4: Tertiary Schooling: College enrollment, (% gross)



Source: World Development Indicators, December 2024

Though India is close to its current benchmark, tertiary enrolment will have to be increased by 7.5% points in next five years to meet the minimum UMIC benchmark of 40.7% (**Figure 4**). To reach the HIC benchmark of 61.7% it will require an improvement of 28.6 percentage points over twenty-five years. We cannot rest on our laurels, in our quest to make Bharat Viksit by 2047.

Table 4 presents India's estimated number of enrolled students at the tertiary levels for 2023, using population projections from both the Technical Group on Population Projections and the UN Population Division. Estimated Student enrolled = Gross enrolment rate of cohort (%) * Cohort (18-223) Population (million). this yields an estimate 50 million tertiary students using TGoPP, and 52 million, using UNpop.

Table 4: Tertiary enrolment Gross rates & numbers

		Technical group on Pop		UN Population	
	Enrolment	Pop aged	Enrolled	Pop aged	Enrolled
	Gross (%)	(Millions)	(million)	(Millions)	(million)
Tertiary Enrolment Gross(%)		Pop aged 18-23yr			
2023	33.1	150	50	156	52
2030 (proj)	40.7	141	58	150	61
2050 (proj)	61.7	na	na	131	81

Sources: WDI/UNESCO (completion rates), UN population (2024 rev).
Technical Group on Pop projections (2020); na = not available

Although India's tertiary enrolment rate (33.1%) is below that of China and the MIC4 (Vietnam, Indonesia, Thailand, and Mexico), India's absolute enrolment is still 2.2 times that of the MIC4 combined (**Table 5**).

Table 5: Comparison of Youth enrolled in Tertiary education

	India	Vietnam	Indonesia	Thailand	China	Mexico
Tertiary Enrolment Gross(%)						
Enrolled (million)	52	3	12	3	72	6
Enrolment Rate(%)	33.1	42.2	45.1	46.2	74.8	46.4
Pop aged 18-23(mil)	156	8	26	6	96	13

Sources: WDI/UNESCO (completion rates), Population Division (2026), Vietnam & Mexico are 2022

4.2.1 Courses and Programs

The division of tertiary education between STEM courses and Humanities and Arts is emerging as a factor in determining productivity and growth. India has also introduced distance learning, in addition to the conventional Physical facility-based learning in tertiary education; these are classified as "distance mode" and "regular mode" respectively. The distribution of tertiary student across programs and mode, for the latest available year (2020-21) is shown in **Table 6**. In regular mode, 24.1% of students were enrolled in B.A. programs, 12.6% in B.Sc. and 10.3% in B. Com. In 2020-21 (rows 1 to 3, **Table 6**). Total enrollment in graduate courses continued to grow during the entire period 2017-18 to 2021-22. During this period, the fastest growing undergraduate programs were B. Pharma, B. Sc Nursing, BBA LLB, and B.Ed. B.Sc. was the only program in which enrolment declined (-0.6).

Table 6: Enrolment, Share & Growth in Regular & Distance Programs: 2021-22

		All programmes			Regular Mode			Distance mode			Raio:
	Graduate programmes	Abs	Share	CAGR	Abs	Share	CAGR	Abs	Share	CAGR	Distance/
		(Lakhs)	(%)	Fy22/Fy18	(Lakhs)	(%)	Fy22/Fy18	(Lakhs)	(%)	Fy22/Fy18	Regular
		1	2	3	4	5	6	7	8	9	10
1	Bachelor of Arts (BA)	113.3	26.9	4.5	90.4	24.1	3.6	19.5	42.6	4.2	0.22
2	B.Com	43.4	10.3	2.0	38.7	10.3	2.2	4.3	9.4	-1.9	0.11
3	B.Pharma	4.5	1.1	19.0	4.5	1.2	19.0				0.00
4	Bachelor of Science (B.Sc)	49.7	11.8	0.8	47.2	12.6	0.7	2.2	4.8	-0.2	0.05
5	B.E/B.Tech	38.5	9.1	-0.6	38.5	10.2	-0.6				0.00
6	BCA	6.2	1.5	5.5	5.7	1.5	7.2	0.5	1.1	-7.1	0.09
7	B Ed	15.2	3.6	9.9	14.9	4.0	10.0	0.3	0.7	5.6	0.02
8	BBA	7.2	1.7	10.9	6.6	1.8	11.8	0.5	1.1	0.7	0.07
9	LLB	4.6	1.1	7.6	4.6	1.2	7.7	0.0	0.0	-4.2	0.00
10	BSc Nursing	4.0	1.0	13.6	4.0	1.1	13.7	0.0	0.0	-2.2	0.00
11	M.B.B.S.	3.2	0.8	7.3	3.2	0.9	7.3				0.00
12	Post-Graduate programmes										
13	Master of Arts (MA)	20.9	4.9	7.2	11.4	3.0	6.1	8.2	18.0	5.0	0.72
14	MBA	6.5	1.5	2.8	5.3	1.4	5.7	1.2	2.6	-6.4	0.23
15	M.Com	5.2	1.2	3.1	3.4	0.9	4.2	1.5	3.3	-2.9	0.45
16	M.Sc	9.5	2.3	7.6	8.3	2.2	8.3	1.1	2.5	1.8	0.14
17	Sub-total (Tertiary)	331.7	78.7	3.7	286.8	76.3	3.4	39.5	86.3	2.3	0.14
18	Other Tertiary	89.8	21.3	5.2	89.1	23.7	6.6	6.3	13.7	9.6	0.07
19	Total Tertiary	421.6	100.0	4.0	375.8	100.0	4.1	45.7	100.0	3.2	0.12

Source: All India Survey on Higher Education (AISHE), 2021-22

At the postgraduate level (regular), M.Sc. had a share of (2.2%) in 2021-22, but at 8.3% was the fastest growing program (line 18, **Table 6**). The share of Masters of arts (MA) program in post-graduate enrolment was however higher than the share of Bachelor of Arts (BA) in under-graduate enrolment.

In the distance mode, enrolment was concentrated more heavily in B.A (42.6%) and M.A (18%) and these were also the fastest growing programs between 2017-18 and 2021-22 (**Table 6**). Enrolment in distance MBA and M. Com courses declined during this period. The demand for distance education seems to be related to the desire to get a (under-) graduate or post-graduate degree to enhance credentials, rather than to learn and train for specific jobs. This in turn related to the practice of credential-based hiring rather than job skill-based hiring for basic and medium skill jobs.

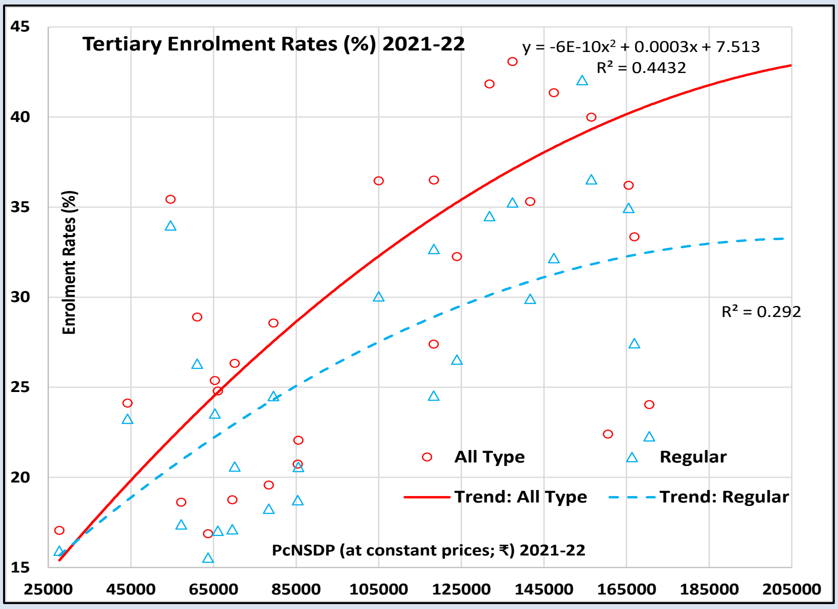
4.2.2 Enrolment Rates across states

As State-wise completion data are not available for tertiary education, enrolment rates are used to analyses inter-State performance. AISHE 2021-22 provides tertiary enrolment data in absolute numbers, which are converted into enrolment rates using the population aged 18-23 years for each State (Enrolment/Population aged 18-23) *100. State-wise estimates are available by mode- Al, Regular, and Distance.

Figure 5 shows enrolment rates in All Type & Regular modes for 2021-22 across States and Union Territories, arranged according to their per capita Net State Domestic Product (PC

NSDP) for 2021-22. The regression trendline between All enrolment and per capita Net State Domestic Product (Pc NSDP) is shown in red in **Figure 5**, with an R^2 of 0.44. The R^2 for regular mode is much less (0.29) sowing a weaker dependence on Per capita NSDP. [9]

Figure 5: Tertiary State wise Enrolment Rates at different level, 2021-22



Source: Author's Calc based on 1. AISHE 2021-22, (Table- 6 (a) & (b), 2. Population projection for India & States 2011-36 (Table 20) and for NE & UT- pop-proj. (Education.Gov.in) 3. PCNSP: National Statistics Office (NSO), RBI (on Aug 29, 2025).

Using the regression equation from **Figure 5**, an expected or benchmark enrolment rate (all) is calculated for each State based on its Pc NSDP, and the gap is defined as the difference between actual and expected enrolment. States are then grouped by over-performance (positive gap) and under-performance (negative gap), with States having a gap of +/- 3.0% [= (std.dev) 8.9%/3] points defined as having little or no gap (**Table 7**). Uttar Pradesh (+4.5%), Madhya Pradesh (+5.3%) and Manipur (+13.3%) were above the enrollment rate expected of their PCNSD (among States with per capita NSDP less than ₹10,000). Among States with per capita NSDP of more than Rs. 10,000/ Arunachal Pradesh (+1.9%), Delhi (+4.0), Uttarakhand (+5.2%), Himachal Pradesh (+5.7%), Tamil Nadu (+7.5%), Chandigarh (+20.4%) and Puducherry (+24.3%) performed better than expected at their PCNSDP (**Table 7**, 1st 3 columns).

[9] The regression trendline between Distance Mode and PCNSDP has an R^2 of 0.31.

Table 7: Performance of States in Tertiary Enrolment: All Types (2021-22)

Performance of States in Tertiary Enrolment : All (2021-22)			
	Negative Gap	**Little or No gap**	**Positive Gap**
PcNsdp < ₹10,000	Tripura (-8.0)	J&K (+0.1)	UP (+4.5)
	ChhattisG (-7.8)	WB (+0.7)	MP (+5.3)
	Assam (-7.3)	Meghalaya (+0.8)	Manipur (+13.3)
	Odisha (-6.7)	Rajasthan (+1.0)	
	Nagaland (-6.7)	Bihar (+1.7)	
	Jharkhand (-4.1)		
PcNsdp > ₹10,000	A&NIslands(-17.8)	MH (-2.7)	Delhi (+4.0)
	Gujarat (-17.2)	TelanG (+0.2)	Arunachal (+1.9)
	Goa (-8.1)	Andhra (+1.9)	UttaraK (+5.2)
	Haryana (-7.5)	Kerala (+2.7)	HP (+5.7)
	Punjab (-7.2)		Tamil Nadu (+7.5)
	Sikkim (-6.2)		Chandigarh (+20.4)
	Karnataka (-4.5)		Puducherry (+24.3)
	Mizoram (-3.2)		

Source: Authors calc based on AISHE 2021-22.; Note: PC NSDP is for 2021-22. Gaps are in brackets.

Though major States above the national average of 28.4% include Sikkim (38.8%), Goa (35.7%), Karnataka (36.2%) and Mizoram (32.3%) their enrolment rate is below the rate expected of States at their level of per capita NSDP'.

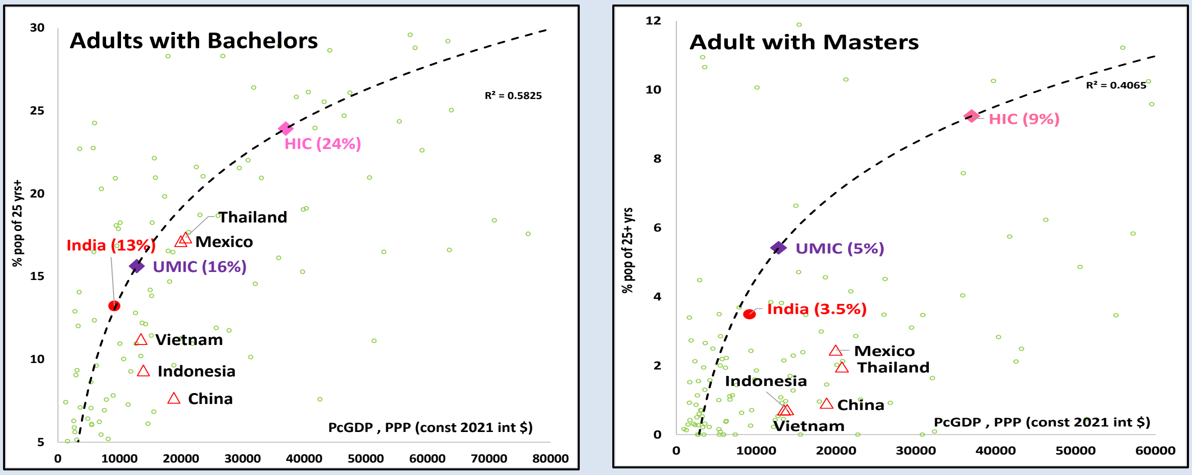
4.3 Tertiary Attainment: Adult (25+)

This section compares the tertiary education levels of India's adult population, aged 25 and over, with that of other countries. India's share of adults (25+) with a Bachelor's or equivalent was 13.2% in 2023 (**Figure 6**), 0.2% points above the expected/benchmark level at its per capita GDP. In contrast, Vietnam (-5%), Indonesia (-7%), Mexico (-2%) and Thailand (-2%) were all below their expected/benchmark levels, with China showing the largest negative gap (-11%). India however, needs to increase the percent of students with bachelor's or equivalent by 2.4% points in 5 years to reach min UMIC benchmark, and by 10.7% points to reach min HIC benchmark in 25 years.

India's share of adults (25+) with a Master's or equivalent was 3.5% in 2023 (**Figure 6**, 2nd panel) which is (-) 0.7% point below the expected/benchmark level at its per capita GDP. India's potential competitors had a larger performance gap on this indicator: Vietnam (-4.9%), Indonesia (-5.0%), China (-5.9%), Mexico (-4.6%) and Thailand (-5.2%) are all below their expected/benchmark levels. The share of adults with Masters or equivalent needs to be increased by 1.9% points by 2030 (UMIC), and by 5.7% points by 2050 (HIC).

This comparison of higher education suggests that historically, tertiary education was more important for India's service-oriented economy, than it was for the manufacturing focused economies of East and South East Asia.

Figure 6: Adults with Bachelor & Master Degree (% of population 25+)



Source: World Development Indicators, December 2024

National Education Policy 2020 (NEP 2020) noted that students completing Grades 11-12 with vocational subjects often lacked clear pathways to continue their chosen vocations in higher education. Admission criteria in general higher education institutions were not aligned to accommodate vocational qualifications, resulting in limited vertical mobility for students from the vocational stream. NEP 2020 proposed the integration of vocational education within Higher Education Institutions (HEIs) will offer vocational education either independently or in partnership with industry and NGOs. The B.Voc. programs, vocational courses will be made available within regular Bachelor's degree programs, including four-year multidisciplinary degrees. HEIs may also offer short-term certificate courses, integrate 'Lok Vidya' into vocational curricula, and explore delivery through Open and Distance Learning (ODL) modes.

4.4 Employability of the Credentialed

The issue of the employability of those who have obtained credentials has come to the fore in the past decade. Either the degree does not measure what they are supposed to have learnt, or the course curriculum is so divorced from the skills required in jobs, that they are not employable. Those who have graduated from professional courses (MCA, BE/BTech) are more employable than those who have general education degrees (BA, BCom, B Pharma, BSc). MBAs have the highest employability of 72.3% in 2026, followed by BE/BTech at 70.2% and MCA at 68.2%. Those with general education have an employability of between 55.6% for BA degree holders and 62.8% for BCom degree graduates, in 2026 (**Table 8**).

Table 8: Employability of Graduates from University & Professional programs

Year	2019	2020	2021	2022	2023	2024	2025	2026	CAGR
Bachelor of Arts (B.A.)	29.3	48.0	42.7	44.2	49.2	47.1	54.0	55.6	9.6
Bachelor of Commerce (B.Com)	30.1	47.0	40.3	42.6	60.6	48.1	55.0	62.8	11.1
Bachelor of Pharmacy (B.Pharma)	36.3	45.0	37.2	44.6	57.5	54.0	56.0	58.0	6.9
Bachelor of Science (B.Sc)	47.4	34.0	30.3	38.1	37.7	51.3	58.0	61.0	3.7
Master of Computer Applications (MCA)	43.1	25.0	22.4	29.3	30.6	64.6	71.0	68.3	6.8
Bachelor of Engineering/ Technology (B.E/B.Tech)	57.1	49.0	46.8	55.2	57.4	64.7	71.5	70.2	3.0
Master of Business Administration (MBA)	36.4	54.0	46.6	55.1	60.1	71.2	78.0	72.8	10.4
Average of									
University Courses	35.8	43.5	37.7	42.4	51.3	50.1	55.8	59.3	7.5
Professional Programs	45.5	42.7	38.6	46.5	49.4	66.8	73.5	70.4	6.4
STEM	46.0	38.3	34.2	41.8	45.8	58.6	64.1	64.4	4.9

Source: Global Employability Report 2025 & 2026; Global Employability Test (GET).

Employability among all post school degree holders (including from Polytechnics) has shown gradual improvement between 2019 and 2026, rising from 47.3% to 56.4% in aggregate (**Table 8**). BCOMs have shown the fastest increase of 11.1% per annum (compound growth), followed by MBAs with a compound annual increase of 10.4% over seven years (column CAGR, **Table 8**). Average employability for general education has increased at a faster rate (7.5% per annum), than for professional degrees (6.4% per annum) suggests a steady recovery and better alignment of higher education with market needs.

The slow improvement in employability of BSc (3.7% per annum) and BE/BTech (3.0%) degree holders, and STEM courses in general (4.9% per annum) suggest that there is great scope of improving the quality of pedagogy, by replacing outdated instruments & lab equipment, and introducing an apprenticeship/ internship program for Professors in industry. This issue may also be connected to the difference in minimum learning outcomes in Arithmetic vs Reading in school (section 6) with the much lower MAP relative to MRP.

Top performing States by Youth Employability, were Utter Pradesh (78.6%), Maharashtra (75.4%), Karnataka (73.9%), Kerela (72.2%) and Delhi (71.2%) in 2026 (India Skills Report, 2026).

4.5 Institutional Capacity

Table 9 presents the distribution of universities in 2021-22 and the change since 2017. State Public Universities form the largest share (37%), with 423 institutions, followed closely by State Private Universities, which account for 35%. State Private Universities also show the highest growth, adding 129 institutions since 2017. Institutions of National Importance make up around 14% of the system and have increased by 52 during this period. In contrast, Deemed Universities both private and government form a small share of the total and show marginal change. Central Universities account for about 5% of all universities and have expanded modestly. Overall, the growth in the university system is driven mainly by State Private Universities and Institutions of National Importance, while other categories have remained stable.

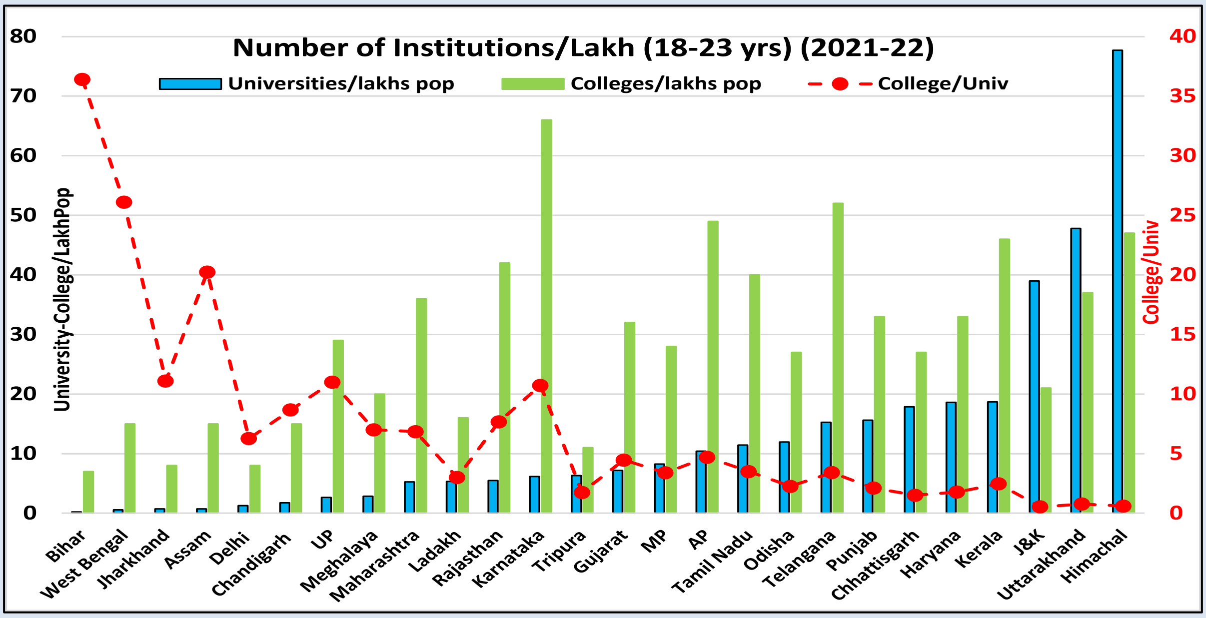
Table 9: Share of different type Universities, & Change (2017-18 to 2021-22)

Number of Universities	No. of Univ	Share(%)	Change: 2017-18 to 2021-22	
	2021-22	2021-22	Numbers	Shares (%)
State Public University	423	37	72	-3.0
State Private University	391	34	129	4.4
Deemed University Private	81	7	1	-2.0
Institue of National Importance	153	13	52	1.9
Central University	53	5	8	-0.5
Deemed University Government	33	3	0	-0.9
Total	1134	100	262	0.0

Source: All India Survey on Higher Education (AISHE), 2021-22

Figure 7 shows the availability of universities and colleges per lakh population (18-23 years) across major states. The pattern is uneven, and in most states, college presence far exceeds university presence. Large states such as Bihar, West Bengal, Jharkhand and Assam have very low university density (0.2-0.7 per lakh youth), yet their college numbers are much higher ranging from 7 to 15 per lakh youth. Even in states with relatively better access Delhi (1.3 universities; 8 colleges) and Uttar Pradesh (2.6 universities; 29 colleges) the gap remains. Southern and western states such as Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu and Gujarat show colleges outnumber universities by a large margin.

Figure 7: University & College Density (per lakhs): 2021-22



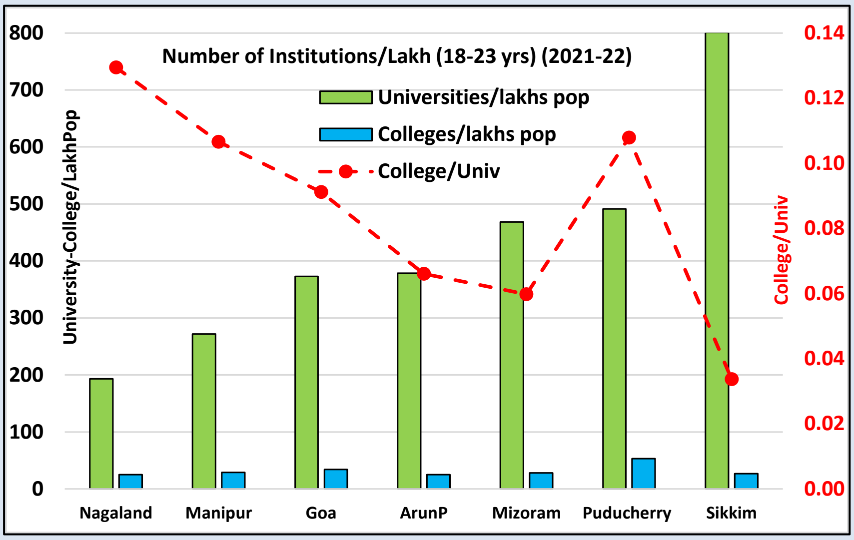
Source: All India Survey on Higher Education (AISHE), 2021-22.

Overall, the national picture suggests that India's higher education system has grown through colleges far more than universities, leading to limited university-level capacity relative to the size of the youth population.

In contrast to major states, the North-Eastern states and some Union Territories (**Figure 8**) show a completely different pattern. The number of universities per lakh youth is extremely high, possibly because the population base is small, while the number of colleges remains limited. As a result, these regions have more universities than colleges in per lakh terms.

States such as Arunachal Pradesh, Mizoram, Sikkim and Manipur report very high university density but only a modest number of colleges. This creates very low college-to-university ratios (often below 1), the pattern is similar in small UTs like Puducherry and Goa. This imbalance indicates that NE states and UTs require more colleges to create a balanced higher education structure. Unlike large states where colleges are far ahead of universities the challenge here is to expand college capacity.

Figure 8: University & College Density (per lakhs): NE states & UT's



Source: All India Survey on Higher Education (AISHE), 2021-22.

4.6 Programs and Initiatives

India's tertiary education system is undergoing major reforms to expand access, improve quality, and make learning more flexible and employment-oriented. Recent policies and initiatives focus on increasing enrolment, strengthening universities and colleges, promoting digital and multidisciplinary learning, and improving governance and regulation. Together, these efforts aim to build a higher education ecosystem that supports both academic inclusivity and the emerging needs of the labor market.

NEP 2020 proposed major reforms to expand and improve higher education in India. The policy aims to increase the Gross Enrolment Ratio (GER) in higher education from 26.3% in 2018 to 50% by 2035, including vocational and online learning. To give students more flexibility, NEP introduces Multiple Entry and Exit Options, where an undergraduate program allows a certificate after one year, a diploma after two years, and a three- or four-year bachelor's degree, with a research option in the fourth year. The policy also plans a new Higher Education Commission of India (HECI) as a single regulatory structure replacing bodies like the UGC and AICTE, with separate verticals for regulation, accreditation, funding, and academic standards. NEP further promotes digital transformation through the National Educational

Technology Forum (NETF) to support e-learning, AI-enabled tools, and blended teaching-learning models. Overall, these reforms seek to improve access, flexibility, quality, and governance within the higher education system.

As part of NEP 2020's push for digital transformation in higher education, **SWAYAM** serves as national Massive Open Online Course (MOOC) platform, 5.15 crore enrolments, 16,530+ courses, and 388 universities permitting up to 40% credit transfer. In February 2024, the **SWAYAM Plus** initiative was launched; it delivers industry-integrated courses in high-demand areas such as AI, Data Analytics, and Healthcare, forming the base of the Digital University. [10]

Academic Bank of Credits (ABC), platform securely stores, accumulates, and transfers academic credits earned by students across recognized educational institutions. It acts as a digital "credit bank," where each learner's credits are recorded through their unique APAAR ID, enabling flexible learning and smooth credit mobility under the Multiple Entry-Exit system.

Hoque (2025), examined the integration of Academic Bank of Credits (ABC) with MOOCs among Social Sciences 186 students of Bihar central university.[11] The study reports improvement in research & critical thinking, communication, and interdisciplinary understanding and application of theoretical knowledge to real-world situations. Students also reported autonomy in designing learning paths and deciding what, when, and how to learn. Students reported positive outcomes in skill development, particularly data analysis and practical applications. Author found that students "appreciate the flexibility and personalized learning opportunities, challenges such as managing workloads, perceived lack of depth in some MOOCs and technical issues hinder the ABC-MOOC model's effectiveness. Concern about limited interaction, affecting collaborative learning, also emerged." Authors suggested that improvements are needed in course quality, workload support, and infrastructure.

Rashtriya Uchchatar Shiksha Abhiyan (RUSA) 2013, designed to support State and State-aided higher education institutions in improving access, equity, quality, and employability. The first phase of the scheme was launched in 2013 and the second phase was launched in 2018. Now, in the light of the National Education Policy, RUSA scheme has been launched as Pradhan Mantri Uchchatar Shiksha Abhiyan (PM-USHA). *Dobi and Tripathi (2020),* found an improvement in male & female GER in Govt Degree Colleges in Jammu & Kashmir[12].

PM-USHA strengthens innovative pedagogy, learning, digital infrastructure, accreditation, and governance across colleges and universities. It promotes flexible learning through Multiple Entry-Exit, the Academic Bank of Credits, Choice Based Credit System (CBCS), and digital education platforms such as SWAYAM. It also aims to enhance research, skilling, and industry linkages so that higher education becomes more multidisciplinary, employment-oriented, and aligned with NEP 2020 targets for quality and participation. *Shanti Priya & Vijayalakshmi (2025)*, that institutions participating in PM-USHA increased infrastructure investment by 30% increase over five years. Funds have also been used for expansion of digital infrastructure such

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[10] Details discussed earlier in Section 6.4.1.

[11] By combining quantitative and qualitative data; sample comprised 186 students for a questionnaire survey and 40 students for semi-structured interviews, specifically from Social Sciences programs such as Economics, Psychology, Sociology, Political Science, Hindi, History, and English.

[12] Based on 15 Government Degree Colleges from four districts of Jammu & Kashmir (Anantnag, Pulwama, Kulgam, Shopian), selected through stratified sampling by literacy levels; institutions established before 2010-11 and offering Arts, Science, and Commerce undergraduate programs.

as smart classrooms and e-libraries. 70% participants reported improved pedagogical skills after attending PM-USHA-sponsored training sessions

Vidya Lakshmi Portal (August 2015), is a single-window digital platform that allows students to apply for education loans from multiple banks in one place. It connects students with banks following Indian Banks' Association (IBA) guidelines, which require loan applications to be processed within 15-30 days. The portal simplifies the loan process by providing a common application form, tracking facility, and access to government scholarship links, helping students secure timely financial support for higher education. *Gagan and Malagi (2025)* Survey data from 286 student respondents indicate, that (1) "Digital loan services are more effective than traditional methods", (2) digital channels improve timely approval.

National Scholarship Portal (NSP) is a single-window digital platform of the Government of India that brings together scholarship schemes from the Centre, States, UGC, AICTE, and other agencies. It allows students to register, apply, and track applications online, while providing scheme-wise eligibility and documentation details. By centralizing the entire process, NSP improves transparency, reduces duplicate entries, and ensures timely and efficient disbursement of scholarships to eligible students across the country. *Mohapatra,* impact evaluation report on National Scholarship Portal have contributed to improving access to higher education among disadvantaged groups.

Unnat Bharat Abhiyan (UBA) 2.0 is a flagship rural development initiative of the Ministry of education, which connects higher education institutions (HEIs) with local communities. Under UBA 2.0, 688 selected HEIs both technical and non-technical have adopted around 3,555 villages to support their development. Institutions conduct surveys, identify local challenges, and work with Panchayats to prepare village development plans, which are finalized through Gram Sabhas. IIT Delhi serves as the National Coordinating Institute. The program focuses on key areas such as sanitation, water management, rural infrastructure, energy access, education, health, agriculture, skill development, and awareness about government schemes, aiming to link academic expertise with grassroots needs for sustainable rural development.

4.7 Summary & Conclusion

This section summarizes the analyses of Tertiary education in India. It covers enrolment rate at International, national and state-level, employability outcomes, tertiary attainment, along with the programs and schemes aimed at improving quality, pedagogy and alignment with labor-market needs.

At the Inter-national level, the Gross Enrolment Ratio (GER) for tertiary education was 33.1% in 2023, at around the benchmark expected at India's per capita GDP. States which have performed above the level expected of their Per capita NSDP (PCNSDP) include Uttar Pradesh, Madhya Pradesh, Manipur, Uttarakhand, Himachal Pradesh, and Tamil Nadu. The number of students enrolled in India's tertiary education is estimated to be 50-52 million. This is less than Chinas, but 2.2 times that of Vietnam, Indonesia, Thailand and Mexico taken together, despite their performance being better than ours for their level of PCGDP. The GER for tertiary education must keep pace with the projected pace of per capita GDP growth. This requires an increase in Tertiary GER of 7.5% points, to 40.7 % by 2030, and an increase of 28.6% points to 61.7% by 2050.

Several programs and initiatives aim to improve access, quality, and employability outcomes. SWAYAM provides a MOOC (Massive Open Online Course) platform for online learning. ABC (Academic Bank of Credits) enables digital storage and transfer of academic credits. PM-USHA supports infrastructure, governance, and quality improvements in higher education.

Employability of graduates has improved from 47.3% to 56.4% on average, between 2019 to 2026. Professional degrees such as MBA (72.3%), BE/BTech (70.2%), and MCA (68.2%) continue to show higher employability, while general degrees like BA (55.6%) and BCom (62.8%) lag but are improving faster. The slow improvement in employability of BSc (3.7% per annum) and BE/BTech (3.0%) degree holders, and STEM courses in general (4.9% per annum) reflecting the need for better pedagogy, updated laboratories, and stronger industry linkages.

In terms of attainment, India's share of adults (25+) with a Bachelor's degree is 13.2%, slightly above the level expected of its per capita GDP. This is better than the performance of Vietnam, Indonesia, Mexico, and Thailand for their per capita GDP. The challenge will be to raise this to 15.6% (2030) and 23.9% by 2050, in line with the projected increase in PCGDP. The relative performance in Master's degrees is less than for Bachelors, 3.5% fewer adults having an MA than the PCGDP related benchmark. However, Vietnam, Indonesia, China, Thailand and Mexico showing larger negative gaps.

The National Education Policy (NEP) 2020 outlines major reforms for tertiary education expanding the Gross Enrollment Ratio to 50% by 2035, integrating vocational education within tertiary education, and accelerating the adoption of online and digital learning through platforms such as SWAYAM. Together, these shifts aim to improve access, quality, and employment relevance across India's higher education system.

One of the recurring problems of Higher education in India is its weak connect with the skills required to become employable. The following steps can be considered to improve the link between Higher education, Job skills and formal employment.

1. Map every University to local industry and significant regional economic actors.
2. Introduce Faculty Apprenticeships with industry, changes rules to make these eligible for faculty Sabbatical and approved refresher course work and/or retraining.
3. Make provision in all engineering departments for appointment of "Professor of Practice" from the set of retired or serving engineers in Industry.
4. Liberalize the rules for setting up and running specialized colleges, such as for risk analysis and risk management. Regulate Private colleges on the basis of learning outcomes and employability (GET test), then resident the number of resident professors.
5. Soft skill: Ability to discuss and debate, search for questions and answers, is best learnt by doing. Universities should promote forums to facilitate such activities.
6. National and State universities should have as one of their primary goals, searching for cost-effective, sustainable solutions to National and State problems, respectively. The learning occurs by the attempt to solve problems, even if few solutions are found
7. Complete liberalization of Govt rules for STEM professors, conferences foreign visits and foreign visitors.

5. Comparative Scale of Human Capital

In an international context, the scale of India's Human capital is as, if not more, important than attainment rates, as this determines international comparative advantage, and evolving (dynamic) comparative advantage. **Table 10** presents two sets of estimates of educational attainment of India's adult population aged 25 years & over. Number of adults with given level of education are based on two sets of population estimates; One, the Technical Group on Population Projections, and two the UN Population Division. Adults at specific education (mi) = Population aged 25 & over (mi) * Per cent of total adults with the specific attainment (%).

Table 10: Number of Adults (25+) with different levels of Education

		Technical group on Pop		UN Population	
	Completion Rates (%)	Pop aged (Millions)	Completers (million)	Pop aged (Millions)	Completers (million)
Primary Completed					
2023	65.6	795	522	820	538
2030 (proj)	78.6	906	712	936	735
2050 (proj)	93.0	na	na	1164	1083
Lower secondary completed					
2023	52.2	795	415	820	428
2030 (proj)	62.9	906	570	936	589
2050 (proj)	81.4	na	na	1164	947
Upper secondary completed					
2023	33.7	795	268	820	276
2030 (proj)	46.8	906	424	936	438
2050 (proj)	65.0	na	na	1164	757
Bachelors completed					
2023	13.2	795	105	820	108
2030 (proj)	15.6	906	142	936	146
2050 (proj)	23.9	na	na	1164	278
Masters completed					
2023	3.5	795	28	820	29
2030 (proj)	5.4	906	49	936	51
2050 (proj)	9.2	na	na	1164	108

Source: Author calculation based on World Development Indicators, December 2024 & Census of 2011, Population projection for India & States 2011-36, Report of the Technical group on population projection, July 2020 (MoHFW).

In 2023, based on Technical Group estimates, around 522 million adults had completed primary education, 415 million had completed lower secondary education, and 268 million had completed upper secondary education (**Table 10**). Corresponding estimates using UN population projections are slightly higher, at about 538 million, 428 million, and 276 million, respectively. Even at the tertiary level, India had approximately 105-108 million adults with a bachelor's degree and nearly 28-29 million with a master's degree (**Table 10**).

5.1 International comparison of Educated Adults

Table 11 shows, that the number of adults with primary and lower secondary education in India is significantly lower than in China (982 mil & 742 mil, respectively), but the gap is only 15% at the upper (overall) secondary school level. Number of Indian adults with primary, lower secondary and upper secondary education is 1.8 to 2 times that of Vietnam, Indonesia, Thailand, and Mexico combined (MIC4).

Table 11: International comparison of adults with different levels of education

	India	Vietnam	Indonesia	Thailand	China	Mexico
Primary Education						
Completers (million)	538	55	139	39	982	64
Completion Rates(%)	65.6	87.3	83.8	74.8	95.8	85.7
Pop aged (millions)	820	63	166	52	1025	75
Lower secondary						
Completers (million)	428	41	94	28	742	52
Completion Rates(%)	52.2	65.6	56.7	54.2	72.4	68.9
Pop aged (millions)	820	63	166	52	1025	75
Upper secondary						
Completers (million)	276	25	65	20	326	31
Completion Rates(%)	33.7	39.1	39.1	39.4	31.8	40.9
Pop aged (millions)	820	63	166	52	1025	75
Bachelors education						
Completers (million)	108	7	15	9	79	13
Completion Rates(%)	13.2	11.2	9.3	17.4	7.7	17.1
Pop aged (millions)	820	63	166	52	1025	75
Masters education						
Completers (million)	29	0	1	1	9	2
Completion Rates(%)	3.5	0.7	0.7	2.0	0.9	2.5
Pop aged (millions)	820	63	166	52	1025	75

Sources: WDI/UNESCO (completion rates), Population Division (2026)
Note: China rates are 2020, Maters rates for Thailand 2022 & Mexico 2020

For bachelor's-level education, India's adult attainment rate was higher than that of Vietnam, Indonesia, and China, but lower than Thailand and Mexico. India has around 108 million adults with a bachelor's degree, which is 1.4 times that of China (79 mil) and 2.4 times that of the MIC4. At the master's level, India's attainment rate (3.5%) is higher than that of Vietnam, Indonesia, China, and Thailand, but lower than Mexico. In absolute numbers, India has approximately 29 million adults which is 3.1 times China's and 6.3 times the MIC4, which together (China + MIC4) have only 13 million Master degree holders (**Table 11**).

6. Research & Development

Research and Development (R&D) forms the core of a knowledge-based economy and depends on both the strength of the education system and the availability of skilled human capital. India's R&D performance is shaped by the education base, the rate at which students complete doctoral programs, overall R&D expenditure, and the size and quality of its research workforce, including researchers and technicians. Firm-level investment in R&D and the ability to translate research into innovation outcomes also play a crucial role. In recent years, the Government has introduced initiatives such as the National Research Foundation (NRF) to promote high-quality research and Startup India to encourage innovation and entrepreneurship. In this section we compare India with some of its potential competitors, using WDI and other international data.

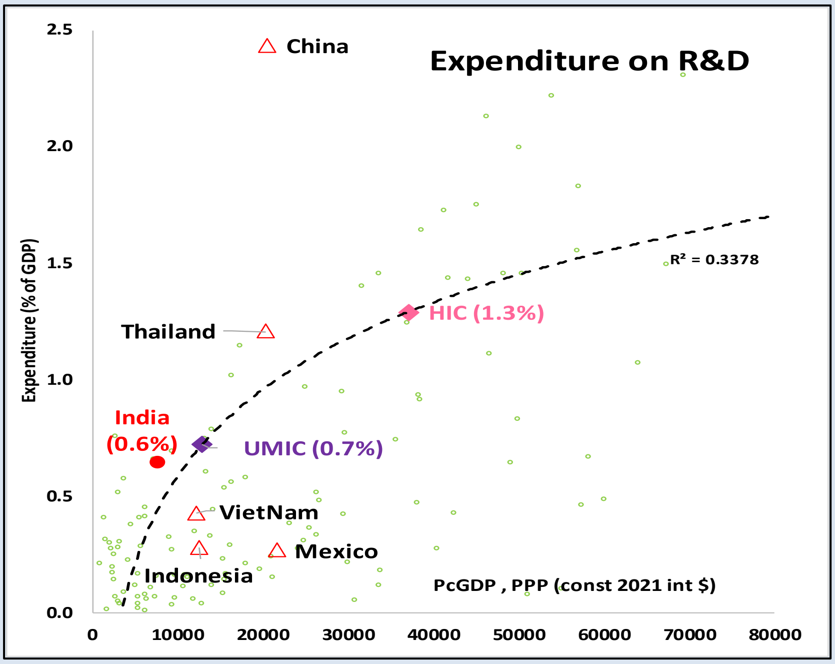
6.1 Doctoral Completion

The paper found no relationship between the percent of adults in a country who had acquired Doctorates, and the per capita GDP of the country. This section, therefore compares India's performance with a selection of lower middle income and upper middle-income countries. India's doctoral completion rate was 0.08% in 2023, which is higher than Vietnam (0.07%) and Indonesia (0.05%), but lower than that of Malaysia (0.10%), China (0.12%), Thailand (0.12%), and Mexico (0.31%).

6.2 R&D Expenditure

India's R&D expenditure was 0.6% of GDP in 2020 (**Figure 9**), 0.2 percentage points above the expected level. Thailand (+0.2%) and China (+1.5%) were also above their benchmark levels, while Vietnam (-0.3%), Indonesia (-0.4%), and Mexico (-0.7%) fall below their benchmark levels (**Figure 9**).

Figure 9: Research and development expenditure (% of GDP)



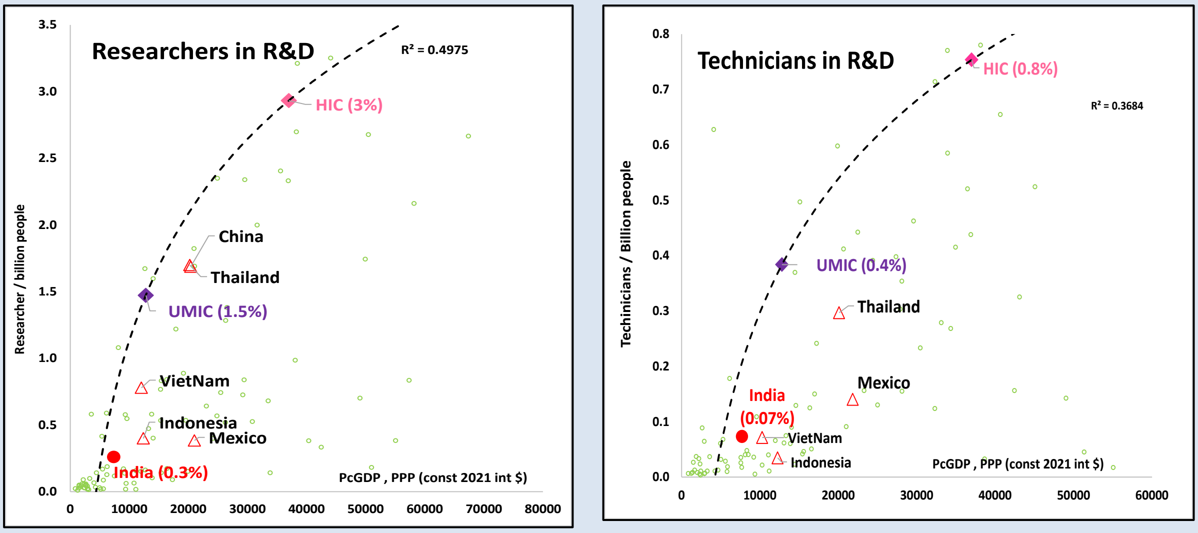
Source: World Development Indicators, December 2024

The base for India in **Figure 9** is 2020, therefore we estimate the value for 2023 (0.7%) assuming that the gap remained the same (0.2% points). This gap is then added to the expected expected/benchmark (0.5%) for India at its 2023 per capita GDP. Based on this we estimate the improvement needed to reach UMIC & HIC benchmarks. This shows that we are likely already above the UMIC benchmark, and need an increase of 0.6% points to reach the benchmark of 1.3% for HIC (2050).

6.3 Researchers & Technician in R&D

India had 0.3 researchers per billion people in 2020 (**Figure 10**), 0.4 percent point below the expected level. Vietnam (-0.6/billion), Indonesia (-1.0/billion), and Mexico (-1.8/billion) fall below their benchmarks, while Thailand and China had a smaller gap of -0.4/billion.

Figure 10: Researchers & Technicians in R&D (per billion people)



Source: World Development Indicators, December 2024

The base for India in **Figure 10** is 2020, therefore we estimate the value for 2023 (0.6%) assuming that the gap remains the same (-0.4% points). This gap is then added to the expected expected/benchmark (1.0%) for India at its 2023 per capita GDP. Based on this we estimate the improvement needed to reach UMIC & HIC benchmarks. This shows that we need to improve researchers per billion people by about 0.9% points to reach the UMIC benchmark of 1.5% and by ~2.3% points to reach the HIC benchmark of 2.9% for HIC India has a much smaller research workforce and must expand it significantly to support future R&D and Innovation.

India had 0.07 technicians in R&D per billion people in 2018 (**Figure 10**, 2nd panel), 0.13 below the expected level. Vietnam (-0.24/billion), Indonesia (-0.33/billion), Thailand (-0.24/billion), and Mexico (-0.43/billion) were also below their benchmark levels, with Indonesia and Mexico showing the largest gap.

The base for India in **Figure 10** (2nd panel) is 2018, therefore we estimate the value for 2023 (0.2%) assuming that the gap remains the same (-0.1% points). This gap is then added to the expected expected/benchmark (0.3%) for India at its 2023 per capita GDP. Based on this we estimate the improvement needed to reach UMIC & HIC benchmarks. This shows that we need to improve technicians per billion people by about 0.2% points to reach the UMIC benchmark of 0.4% and by ~0.6% points to reach the HIC benchmark of 0.8% for HIC.

This again illustrates the big challenge that India faces in training semi-skilled workers for all sectors of the economy, Agriculture, Industry and Services, modern and traditional. This can also be seen as an opportunity to raise the productivity and wages in every sector of the economy, formal and informal, employed or self-employed.

6.4 Firms that do R&D and Innovate

We found no relationship between the percent of firms that spend on R&D, and the per capita GDP of the country.[13] The share of firms which have developed products, improved processes and do R&D in India is 1.4% (**Table 12**). This is higher than Vietnam (0.9%), Indonesia (0.9%), Thailand (0.8%), but lower than Mexico (2.4%) and Malaysia (8.1%). China at 18.2% was way ahead of the pack (**Table 12**). This data suggests that Mexico and Malaysia are likely to be our peer competitors in high tech manufacturing.[14]

Table 12: Firms that spend on R&D (% of firms)

Country	Year	PcGDP	%firms
India	2022	$8,594	1.4
Viet Nam	2023	$13,546	0.9
Indonesia	2023	$13,890	0.9
Thailand	2016	$19,371	0.8
Mexico	2023	$21,917	2.4
China	2024	$23,846	18.2
Malaysia	2024	$34,116	8.1

Source: World Development Indicators, December 2025.

6.5 Innovation

India ranks 38th out of 133 countries (**Table 13**) in the Global Innovation Index (GII). Among major competitors, India ranks 6 positions above Viet Nam (44), 3 positions above Thailand (41), 17 ranks above Indonesia (54), and 20 ranks above Mexico (56). Malaysia is however ranked 4 ranks above India. China is an outlies at rank 10, with 19th rank on inputs, but 5th oh output. This may be connected to its highly successful policy of Reverse Engineering and Developing (READ) technologies of foreign companies located in China, and companies, startups and research institutions possessing advanced technology, innovative solutions, in High Income, technologically developed, countries (HITDCs)

[13] Based on WDI, Dec 2024 data. The discussion is based on updated data from WDI, Dec 2025, which tightens the definition to firms which develop products, process improvement and do R&D.

[14] And also of UK, Japan and USA.

Table 13: Global Innovation Index Ranking, 2025

	GII	Input	Output
Countries	**Rank**	**Sub-Index**	
India	38	52	32
Viet Nam	44	50	37
China	10	19	5
Malaysia	34	30	39
Thailand	45	46	43
Indonesia	55	60	59
Mexico	58	81	52

Source: GII Database, WIPO, 2025

6.6 Patent applications & Hi-Tech Exports

We found no relationship between the Patent applications, residents per million, and the per capita GDP of the country. India reports 19 applications per million (**Table 14**), higher than Vietnam (11), Indonesia (5), Thailand (12), and Mexico (9), but lower than Malaysia (26). China with 1,010 applications per million, is far higher than all other selected countries, except Japan (1,770). The United States (790), Germany (479), France (197), and the UK (173) all report lower patenting levels than China.

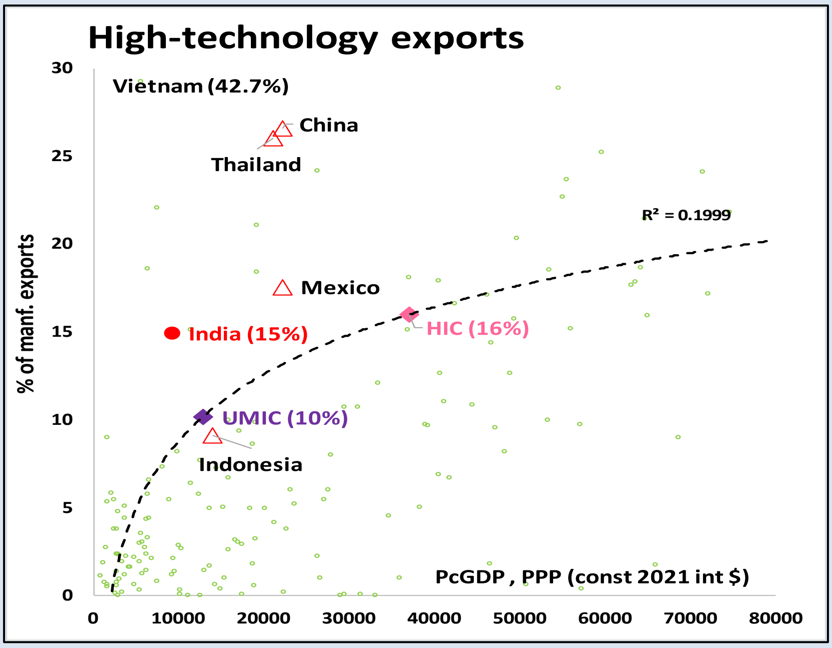
Table 14: Patent applications, Residents /Million population

Country	PcGDP	Patent/Mi
India	$8,050	19
Viet Nam	$12,049	11
Indonesia	$12,757	5
Thailand	$20,245	12
China	$20,407	1010
Mexico	$21,032	9
Malaysia	$29,823	26
Japan	$44,549	1770
UK	$52,872	173
France	$53,901	197
Germany	$62,950	479
United States	$71,318	790

Source: World Development Indicators, December 2024.

India's high-technology exports are 15% (**Figure 11**) of manufactured exports. The UMIC benchmark for 2030 is 10%, and India is already above this level. The HIC benchmark for 2050 is 16%, which India is close to achieving. India's High technology exports were higher than Indonesia (9%) but lower than Mexico (18%), Thailand (26%) and China (27%). China and Thailand are much higher, with a gap of about (+13%) compared to India.

Figure 11: High-technology exports (% of manufactured exports)



Source: World Development Indicators, December 2024

6.7 Programs and Initiatives

India's research and innovation ecosystem is supported by several national programs designed to strengthen scientific talent, expand research capacity, and promote early-stage innovation. These initiatives focus on nurturing young researchers, supporting institutions, and encouraging industry academia collaboration. Together, they aim to build a pipeline of scientific talent and enhance India's overall R&D performance.

The Institutes of Eminence (IoE) initiative is a Government of India program launched in 2017 to empower select universities and higher education institutions to become **world-class teaching and research hubs**. It grants them greater autonomy, funding (for public institutions), and the ability to collaborate globally, with the goal of placing Indian universities among the top-ranked institutions worldwide. 10 Public and 10 private universities/institutes have been selected, with the public universities receiving a corpus of 1000 crore for the purpose.

As reported on the University of Hyderabad web site under the title, "IoE – Initiatives & Impact, UoH Herald (2018)", the IoE initiative has helped promote an "ecosystem of innovation, entrepreneurship and translational research" through Start-ups and public-private partnerships. Improvements are reflected in research output, with the average number of publications per Univ of Hyderabad faculty increasing from about 1-1.5 to nearly 3 annually, including around 30% of publications in Q1 journals.

Government of India (GOI) has also designated several universities and research institutions as Centers of Excellence (CoEs) in frontier areas of science, technology, and innovation. These centers focus on specialized topics such as **nanotechnology, renewable energy, advanced manufacturing, AI, biotechnology, and energy storage.** They are funded under schemes like the Training and Research in Frontier Areas of Science and Technology (FAST) and the Institutes of Eminence (IoE) initiative.

GOI has also initiated Missions in frontier areas like Quantum and AI. **The National Quantum Mission** (NQM) was approved by the Union Cabinet on 19 April 2023, aims to build national capacity in quantum technologies. The Mission supports research and development in quantum computing, communication, sensing and metrology, and quantum materials and devices. Implementation is through four thematic hubs with support for startups and capacity building. The **National Mission for Artificial Intelligence** (2024) to support the development and deployment of AI applications in priority sectors. The Mission focuses on building research capacity, strengthening academia-industry collaboration, and applying AI in areas such as healthcare, education, agriculture, and urban infrastructure.

INSPIRE-MANAK: Innovation in Science Pursuit for Inspired Research-Million Minds Augmenting National Aspiration and Knowledge (2008), aims to identify and encourage scientific talent among students aged 10-15 (Classes 6-10). The scheme invites around 10 lakh idea submissions each year from over 5 lakh schools, from which 1 lakh ideas receive an INSPIRE Award of ₹10,000. Schools can nominate up to five students annually through an online system, and selections are made based on the originality and quality of ideas. Selected students participate in district, state, and national-level exhibitions, and participants reaching the National Level Exhibition & Competition receive mentorship at leading technical institutions. The top 60 projects are recognized as national winners. The National Innovation Foundation serves as the scheme's resource partner.

Mir (2024) assessment of the INSPIRE-MANAK Scheme in Jammu and Kashmir, uses primary data from district, state, and national level competitions along with secondary sources[15]. Findings show that about 1,000 student entries were submitted at the District Level Exhibition and Project Competition (2021-2022), with 95 advancing to the State Level and 17 reaching the National Level, indicating growing interest and awareness among students and teachers. This aligns with the region's broader performance over the past 14 years, where around 24,906 schools have participated; despite having fewer schools than larger states[16]. Jammu and Kashmir has secured a notable share of National Level Exhibition and Project Competition awards, suggesting effective promotion of scientific temperament and creativity at the school level.

NIDHI's PRAYAS (2016) program supports young innovators in converting their ideas into proof-of-concept prototypes. It provides early-stage assistance that allows innovators to experiment & create a workable product ready for incubation and commercialization. As a pre-incubation initiative, PRAYAS is implemented through a Program Management Unit (PMU), with selected incubators (31) designated as PRAYAS Centers (PCs). 401 innovators have been supported, of which 306 companies were started in PCs, 214 prototypes were developed, and 173 IPs were filed. 135 innovators raised Rs 78 crore, and 202 innovators generate 911 jobs.

Prime Minister's Research Fellowship (PMRF, 2018) is a flagship initiative designed to attract India's best young talent into doctoral program at IITs, IISc, IISERs, and top Central Universities and NITs. It supports students pursuing cutting-edge research in priority areas of

[15] Official documents, project documentation, and competition reports from SCERT and related nodal officers in Jammu and Kashmir are used in the study. To obtain qualitative information, a few interviews with participants, instructors, and nodal officials were carried out.
[16] Maharashtra (141,763) & Karnataka (185,211)

science and technology. Fellows receive one of the highest doctoral stipends in the country ₹70,000 to ₹80,000 per month along with a research grant of ₹2 lakh per year. Candidates are selected through a rigorous process under discipline-wise nodal institutes, with entry allowed through direct admission or lateral entry from ongoing PhD program. PMRF aims to strengthen India's research ecosystem by enabling outstanding students to undertake high-quality, nationally relevant research within leading institutions. Between 2018 and 2024, about 3,688 scholars were admitted state-wide.[17]

Bhatia (2025) analysis shows that PMRF Fellows have published 300+ papers in peer-reviewed international journals and conferences (2022-2024). There were more than 45 patent applications, and several technology-oriented innovations, including three start-ups incubated at leading institutions (IIT Bombay, IIT Delhi and IISc). Fellows have collaborated with ISRO, DRDO, and CSIR labs, to integrate academic with applied research. Remaining challenges include, institutional concentration (80% fellows 8 institutions), Disciplinary gaps(public health education-job skilling, governance) and Post fellowship pathways. Awareness campaigns, mentoring initiatives in tier 2, 3 cities and creation of a PMRF Alumni Council are recommended by the Author.

PRISM, Promoting Innovations in Individuals, Start-ups and MSMEs (2014) supports individuals and enterprises in translating ideas into workable prototypes, processes or technology solutions. It also supports to public-funded autonomous institutions and registered societies engaged in fostering innovation, particularly for developing technologies that benefit MSME clusters. This is implemented through 12 TePP Outreach cum Cluster Innovation Centers (TOCICs)[18]. Priority areas include smart materials, waste-to-wealth solutions, and water and sewage management. DSIR assessed the PRISM scheme through survey & interviews of coordinators and innovators. The centers conducted 571 workshops/outreach activities reaching 17,017 individuals, while 1,082 proposals were received during 2015-2020. Most innovators developed prototypes in clean energy, industrially utilizable materials (40) and affordable healthcare (37). With 83% of innovators had completed the project, 42 patents generated and 38 startups noted. Majority of innovators experienced technical challenges transforming prototypes into (fabricated) products. Marketing challenges are even more daunting.

SPARC, Scheme for Promotion of Academic and Research Collaboration (2018) strengthen India's research ecosystem by enabling structured academic and research partnerships between top Indian institutions and globally ranked foreign universities. The scheme supports joint research projects that include mobility of faculty and students, longer-duration visits by international experts, and opportunities for Indian researchers to work in advanced laboratories abroad. SPARC is designed to bring global expertise to address national challenges, deepen bilateral research ties, and enhance the international visibility and ranking of Indian higher education institutions. SPARC approved 284 proposals involving about 100 top international universities, in phase I (2018-20).

According to *Thapar (2025)*, 650 collaborative projects have been supported by SPARC, resulting in almost 1700 research papers, around 80 patents and technology prototypes have

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[17] MoE, 2024-25
[18] Technopreneur Promotion Programme (TePP).

been developed and 900 workshops nationwide. Some of articles from SPARC were published in high impact journals ACS Nano, Chemical Engineering journal and Environment international. It has familiarized faculty and scholars in global research culture & methodology. It has also led to an improvement of curriculum and creation of Indo-German and Indo-Australian collaborative networks.

Anusandhan National Research Foundation (ANRF), established under the ANRF Act 2023, serves as the apex body for providing strategic direction to scientific research in line with the National Education Policy. Its mandate is to seed, grow, and strengthen research and innovation across universities, colleges, research institutions, and R&D laboratories in India. With its creation, the Science and Engineering Research Board (SERB) has been subsumed into ANRF. The Foundation is designed to build strong linkages among industry, academia, government departments, and research institutions, and to create mechanisms for participation and support from industry and State governments to advance India's research and development ecosystem.

Atal Innovation Mission (AIM), established by NITI Aayog in 2016, is the Government of India's flagship initiative to promote a culture of innovation and entrepreneurship through a holistic approach spanning schools, universities, research institutions, industry, and the MSME sector. AIM operates its program through real-time MIS systems and third-party reviews to ensure continuous improvement. At the school level, the **Atal Tinkering Lab** (ATL) program. focused on STEM (Science, Technology, Engineering, and Mathematics), sets up dedicated innovation spaces for students from Grades 6 to 12, enabling hands-on learning with technologies such as IoT, 3D printing, robotics, electronics, and rapid prototyping; so far, 10,000 ATLs have been established across 722 districts in India. At the higher-education and enterprise level, AIM supports **Atal Incubation Centers** (AICs) hosted in universities, institutions, and corporates to nurture early-stage startups by providing technical facilities, mentorship, funding access, partnerships, and co-working and lab spaces. AIM has operationalized 72 AICs, which collectively support more than 3,500 startups, have generated over 32,000 jobs, and include around 1,000 women-led enterprises across sectors such as health technology, fintech, ed-tech, space and drone technology, AR/VR, food processing, and tourism.

The *Athena Infonomics (2023)* assessment of Atal Tinkering Labs adopted a mixed-method evaluation, combining secondary analysis of 1,000 ATLs with primary stakeholder data to review program implementation and outcomes. The findings (N=493), indicate positive learning impacts, 68.8% of schools reported improved academic performance, while 60% observed enhancement in scientific temper and 45.4% noted higher achievement in STEM areas. Teaching practices also shifted, with about 71.8% schools reporting better student-teacher engagement and 71.0% integrating technical basics into learning activities. The impact on student mindset was positive towards science and technology in 74.4% schools, with more students pursuing science for higher studies in 69.4%, better learnings among students in 59.6%, enhancement of 21st century skills in 58.2%, better ability to relate to school curriculum in 42.2%, enhanced innovation skills of students in 40.8%, and spirit of entrepreneurship in students witnessed in 23.1%."

Under Digital India Innovation, MeitY key Digital India innovation initiatives include **TIDE 2.0 Scheme**, launched in 2019 to provide financial and technical support (IoT, AI, Robotics, etc.) through 51 incubators using emerging technologies and aimed at supporting about 2,000 tech startups; **Domain-specific Centers of Excellence,** with 26 CoEs established to drive capabilities in emerging technology areas; the **SAMRIDH Scheme**, launched in 2021 to strengthen accelerators and scale software product startups, targeting 300 startups over three years; and the **Next Generation Incubation Scheme (NGIS)** to handhold 300 software product startups in Tier-2/3 cities through 12 locations under NPSP 2019. Additional initiatives include the SIP-EIT Scheme to reimburse international patent-filing costs for startups and MSMEs, and Digital India-**GENESIS**, a national umbrella program to discover, support, and grow startups in smaller cities through collaborative engagement with government and industry.

Startup India, launched in January 2016, aims to build a strong innovation-driven ecosystem by supporting new enterprises through simplified compliance, a single-window portal, fast-track patent processes, relaxed procurement norms, and easier exit.

6.8 Summary

This section focused on the international comparative analyses of Indian R&D. It covered R&D inputs, such as R&D expenditure, researchers & technicians in R&D, adult population with Doctoral degrees, and firms engaged in R&D. It also considered available measures of output such as innovation index, patents, high-technology exports. Programs and initiatives aimed at strengthening the research ecosystem are discussed.

India's R&D expenditure was 0.6% of GDP in 2020, above the benchmark for its level of PCGDP. It is estimated at 0.7% in 2023. India's R&D/expenditure ratio is larger than those of Vietnam, Indonesia, and Mexico. India's R&D expenditure ratio of 0.2% is above its benchmark, as is Thailand's (+0.2%, but China's is above its PCGDP benchmark by 1.5%. India had 0.3 researchers per billion people in 2020 and is estimated at 1.0 per billion in 2023. In terms of the gap from its Per capita GDP benchmark(-0.4/bi) I was better than Vietnam (-0.6/bi), Indonesia (-1.0/bi), and Mexico (-1.8bi), below that of Thailand (-0.4/bi and China(-0.4/bi) had a smaller gap of -0.4/billion but remain above India. India had 0.07 per billion technicians in R&D in 2018, (estimated at 0.3 per billion in 2023), which was below its PCGDP benchmark by (-)0.13/bi. All comparators were even more below the level expected for their PCGDP; Vietnam (-0.24), Indonesia (-0.33), Thailand (-0.24), and Mexico -0.43), than India.

The proportion of Indian adults (25+) who had completed a Doctorate was 0.08% (2023), a rate higher than Vietnam (0.07%) and Indonesia (0.05), but lower than Malaysia (0.10%), China (0.12%), Thailand (0.13%), and Mexico (0.31%). The share of firms engaged in R&D for innovation was 1.4% (2022), was more than Vietnam (0.9%), Indonesia (0.9%), Thailand (0.8%) but lower than Mexico (2.4%) and Malaysia (8.1%). China, at 18.2%, was far ahead of all, indicating a much stronger base of firms engaged in R&D. India ranked 38th in the Global Innovation Index for 2025. India ranked above Vietnam (44), Thailand (41), Indonesia (54), and Mexico (56), but below Malaysia (34) and far behind China (5). India reports 19 Patent applications per million population, higher than Vietnam, Indonesia, Thailand & Mexico, but far below China (1,010). "High-technology" exports were 15% of manufactured exports, higher than Indonesia (11%) but lower than Mexico (18%), Thailand (26%) and China (27%).

India needs to expand its research workforce to keep pace with the projected growth of per capita GDP. This requires an increase of 0.9 researchers per billion to reach 1.5 per billion researchers by 2030, and an increase of 2.3 researchers per billion to reach 2.9 per billion by 2050. The number of technicians needs to be doubled is 0.2 to 0.4 per billion population in five years and quadrupled to 0.8 per billion by 2050. High-technology exports are an area of strength, already above UMIC benchmark and close to HIC benchmark of 16% for 2050.

The central Government has introduced a number of programs to attract scholars into Doctoral programs, increase patenting activity in Central Govt universities, and improve firm participation in university research. The PMRF (Prime Minister's Research Fellowship) is designed to support research scholars who join doctoral. Initiatives like PRISM, NIDHI-PRAYAS, INSPIRE-MANAK and Atal Innovation Mission (AIM) help innovators and startups develop prototypes and scale ideas. At the institutional level, Institutes of Eminence (IoE) empower select universities to become world-class research hubs, ANRF (Anusandhan National Research Foundation) provides strategic direction to research, and SPARC promotes global academic collaboration. while frontier programs such as the National Quantum Mission (NQM) and National Mission on AI build advanced capacities. Digital India Innovation programs such as TIDE 2.0, SAMRIDH, and NGIS, along with Startup India, build the wider startup ecosystem Together, these initiatives aim to expand India's research base, strengthen innovation, and align R&D with national development goals. The tax subsystem needs to be modified to increase incentives for deep tech R&D by corporations.

7. Summary and Conclusion

India is comparatively well placed international comparative frame, with respect to tertiary education, but not so well in R&D. India's tertiary enrolment rate is almost at the exact benchmark for its per capita income. Its Adult population with Bachelor's degree is slightly above, and with Master's degree a little below the benchmark for its per capita income. Given its enormous population this makes its total, tertiary educated adult population, the second highest in the World after China.

The R&D picture is however, mixed. India's total expenditure to GDP is above the benchmark for its per capita GDP, the researchers per population and technicians per population are significantly below its international benchmark. Despite these handicaps, its High- tech exports/total exports are close to the benchmark for a threshold high income country.

The share of Indian firms doing R&D for innovation is 1.4%, compared to 0.8-0.9% for Vietnam, Indonesia and Thailand, 2.4% for Mexico and 8.1% for Malaysia and 18.2% for China. Indian patents per population are higher than those of Thailand, Vietnam, Mexico and Indonesia, but lower than those of Malaysia and far below those of China, which is just second to Japan. India also ranks higher than most of these countries in the Global innovation Index; India (38), compared to Vietnam (44), Thailand (45), Indonesia (55) and Mexico (58). Malaysia (34) and China (10) are ranked higher. A number policies and programs have been introduced to reduce the big gap with China, but the tax incentives for private R&D could be improved further.

A critical goal of the education and skilling system is employment. The Global employability Test (GET) is one way to measure its effectiveness. Employability of those trained by this system can be divided into three categories. Those graduating from Vocational institutions

(VET) like Industrial Training Institutes (ITI) and Polytechnics have the lowest employability, and those graduating from professional institutions such as Engineering (BE/BTech, Computers (MCA) and Management (MBA), have the highest employability. Graduates of the University-college system (BA, BCom, BSc, MA) fall in middle of the employability spectrum. At the top of the system are the Professional Institutions with employability in the 70-78% range in 2025. Next come the Universities(-colleges), with employability in the 55-58% range. Then come the ITIs at just over 40% and finally the Polytechnics at a little under 30%. The good news is, that Employability has improved across the board during the past six years for which data is available. The simple average increase of employability is 10% points for Polytechnics, 20% points for universities, and 28% points for professional institutions (2019-2025).

The benchmark used in this paper are generally a function of per capita GDP. Absolute numbers of educated and skilled population, labor and work force is relevant when we defining comparative advantage relative to both our comparator countries and vis-à-vis other countries. Even with India's school completion rates lower than higher income comparator countries, the comparative numbers are higher than China's and often exceed it. The number of children completing primary education in India (137 mil) were 1.25 times those in China and more than 2.5 times the combined total of Vietnam, Indonesia, Thailand and Mexico (MIC4). The number of children completing lower secondary school (65 mil) were 1.2 times those of China. The number of children completing upper secondary school (98 mil) were also 1.2 times those China and 3.7 times those of the MIC4 (Vietnam, Indonesia, Thailand & Mexico) combined. The number of students enrolled in tertiary education (52 mil) was more than double those of the four comparators combined.

The above measures are more important for future comparative advantage, than the current stock of adults with different levels of education. Broadly India has a larger number of adults with Tertiary education (Bachelors & Masters) than China, while China has a higher number of adults with primary & secondary education; India's adult population with bachelor's degree was 1.4 times China's, while its adults with secondary education were 0.85 China's. India's stock of adults with primary, lower and upper secondary education was 1.8 to 2 times the corresponding numbers for MIC4 (combined).

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