A Decadal History of IISER Mohali

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A dissertation submitted for the partial fulfilment of
BS-MS dual degree in Science

Indian Institute of Science Education and Research Mohali

December **2017**

Certificate of Examination

This is to certify that the dissertation titled ***A Decadal History of IISER Mohali***, submitted by **Taranpreet Singh (MS12044)**, for the thesis committee duly appointed by the Institute has examined the partial fulfilment of BS-MS dual degree programme of the Institute. The committee finds the work done by the candidate satisfactory and recommends that the report be accepted.

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Declaration

I hereby declare that the work presented in this thesis, titled "A Decadal History of IISER Mohali" has been accomplished by me with the guidance of Dr Ritajyoti Bandyopadhyay of Indian Institute of Science Education and Research Mohali for the partial fulfilment of the BS-MS dual degree programme in Science.

The work presented here has not been submitted either in a segment or full for any degree, diploma to any university, institute or college. For strengthening the arguments, the contribution used in this work has been mentioned explicitly in the reference section.

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In my capacity as supervisor of the candidate's dissertation, I certify that the above statements are true to the best of my knowledge.

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Abstract

The dissertation tracks a decadal history (2007-17) of the Indian Institute of Science Education and Research (IISER) Mohali, with an aim to study the trends of institutionalization of science education and research in contemporary India. Is there a perceptual mismatch between “science education” and “science research” in India? If so, how is it possible to arrive at a synthesis? How far has IISER Mohali been able to address the issue through its pedagogic praxis? The dissertation sets before itself three tasks. First, it lays out the terrain of the prevailing higher education ecosystem in India. An attempt is made to analyze the milieu that prompted a general discourse on the installation of science education and research infrastructures in contemporary times. Second, it tracks the factors that resulted in the foundation of the IISER system in various parts of India. Third, the dissertation conducts a case study of the current state of affairs at IISER Mohali to get a sense of the everyday life of the said system. It is shown how, over the last decade, the system navigated moments of hope and despondency, and could finally establish an endearing example in terms of its contributions to the development of human capital in the field of basic science.

Acknowledgement

I would like to acknowledge many people that generously helped me throughout this thesis whether it's about discussion or giving critical reviews that helped me to shape my ideas. This work would not have been possible without the consistent support of Dr. Ritajyoti Bandyopadhyay. Beside my guide, there are many people assisted me such as Prof. N.S. Sathyamurthy(Ex-Director of IISER Mohali), Prof.Arvind, Dr V. Rajesh, Dr Samrat Ghosh, Dr P. Visakhi are worth mentioning. This work could not have been complete without help and constant support of Mr. Devwrat Dube.I also acknowledge Mohan Lal, Ankit Yadav, Bal Krishan, Mukesh Kumar for their insightful ideas. I thank IISERM student community that gave me the spectrum of views from different horizons on surveying the current students.

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Dedicated to friends and family

Chapter 1

Higher Education landscape of India

Introduction

Education is the most crucial factor for developing the humankind, society and country. The advancement that humanity has ever made emerges predominantly from science and technology. From the social justice point of view, higher education appears to be a veritable equaliser. If it is open to all social classes and accessed by all, higher education can be the most legitimate means to augment mobility. Conversely, higher education sector can also be the best available means to reproduce caste, class, gender, regional and ethnic hierarchies, if it makes itself available to only a few privileged groups. It is thus essential for us to study institutional dynamics of higher education in any society. The scope of the current study is to understand the integral relationship between science education and research operational within the higher education landscape in India. One of the objectives that the study aims to achieve is to develop an understanding of the need and genesis of IISERs.

A bifurcation that exists in science and technology is Pure/Basic/Fundamental Science and Applied Science. Pure Sciences focuses on expanding the knowledge on frontiers of science, whereas applied science concentrates on developing applications based on the scientific theories, which lie in the domain of pure or basic science. All the fascinating technologies of the modern civilisation such as the GPS, Internet, Fibre Optics and artificial intelligence have been made possible because of centuries of research done by scientists. In fact, any technological advancement that has ever been manifested first found expression in a scientific mind and then it took the collective effort of many others to shape that idea into reality. For instance, Lasers came after the years of research based on Raman Effect. Thus, one needs to understand the necessity of Basic or Pure sciences, and it serves as a Launchpad for advanced technologies. Furthermore, technology assists in path-breaking discoveries in pure sciences. Therefore, there is a need to promote pure sciences as much as the applied sciences, as both feed each other.

Science is not only vital for the development but also serves as a framework for thinking and lets people experience and scientifically interpret the world. Further, it evokes people to question their observations, which leads to truth and liberates them from unfalsifiable popular beliefs and religious dogmas.

As we look through the lens of history, the modern science first emerges from the 17th century through to 21st-century building upon the contributions from eminent scientists, technologist, entrepreneurs. Science has changed the way we live in the world and understand it.

Along the path of scientific revolution and breakthroughs, some countries assumed the status of superpower in the world. Arguably, the world wars were non-localised brutal battles owing to the involvement of science and technology. Every aspires to become technologically rich by investing and building their arsenal along with advancement in science and technology.

It is imperative for any country to keep the science and technology growing, for which the government can spend their taxpayer's money in the public educational institutions and on their research and development departments. The more a country invests in science and technology, the more advanced it becomes. Thus, science and technology are of paramount importance and so is the scientific temper of the populace. India has included the promotion of scientific temper as one of the fundamental duties of the citizens.

In Nehru and National philosophy (Parek, 1991) : *India had remained scientifically and technologically backwards and became an easy prey to industrially developed Britain*. Thus, Nehru's policies were focussed on the large-scale industrialisation in India.

It was essential for an infant Independent India to enrol the students in the higher education sector. India had very few universities and colleges that impart education in 1947, demanding an expansion of the educational infrastructure. Attempts to fulfil this demand over the decades resulted in the mass number of universities and colleges. However, quantity does not ensure quality. A large number of universities were solely educational bodies which were not creating a highly-skilled workforce but played the role of stamping certificates and degrees. To fulfil the requirement in the technological sector, the IITs were set up as excellent institutions, and have been producing a mass number of competent engineers. Education from IITs has itself become a norm leading to declining number of student enrolment in science as well as in the number of researchers in basic science. Therefore, at some point in time, it becomes crucial to open the edifices of science institutes in India meeting with international standards, to revive the spirit of Basic Sciences in India.

Motivation for the study

Along the way of the study, it became crucial to find answers to the following two questions:

What is the difference between ***Science Education*** *in Research Institute vs Science Education in Universities?*

What has been the level of contribution by IISERs in International standard research output from India?
(By studying the Publications of IISERs)

The resources that have contributed to this study include data collected from the IISER Mohali faculty members, Detailed Project Report (DPR, IISER Mohali, 2006), the report titled “Genesis of IISERs” (SWARUP, 2015) (available in TIFR library, Pune), Institution repositories and articles in the research journals and non-academic media available over the Internet.

Understanding the higher education landscape of India is a prerequisite to understanding the need for the genesis of IISERs. The first chapter attempts to bring to light the relevant facts about this study. The following chapter then attempts to use the understanding developed in the first chapter to argue for the creation of IISERs owing to a Vacuum that existed before their formation.

Chapter 3 will then take a critical review of the contribution of IISERs in research, keeping IISER Mohali as one case of concern. Nature index rankings have been analysed for the period 2012-2016, and all IISERs have been compared. The rankings and analysis of contribution by the IISERs have been done discipline-wise. The NIRF rankings have also been mentioned, and IISER Mohali’s NIRF rank has been fleetingly discussed.

Having understood how IISERs play a crucial role in elevating the research output of India in basic science as well as science teaching, it is significant to find out if there are any minor or significant structural flaws in these institutes. For this purpose, IISER Mohali is taken as a test case and studied in Chapter 4. What is presented therein is the result of a survey conducted on the current students and the alumni to address what needs to be improved in IISER Mohali. A qualitative analysis of the responses is done subsequently. There is lack of skilled workforce in research and higher education. Since research output of IISERs in basic science is significant and with emphasis on quality education for undergraduates, IISERs seems promising to improve the higher education landscape in India. Thus, there is a need for more IISERs and this has been discussed in chapter 5.

The interview with the Ex- Director of IISERM (Prof. N. Sathyamurthy) has been of supreme importance in the study and is reproduced in the Appendix.

HIGHER EDUCATION SYSTEM IN INDIA AFTER INDEPENDENCE.

When India attained Independence in 1947, the country was in a poor state. As Shashi Tharoor emphasised in his book, (Tharoor, 2016) when the British left India, the economy of India, which was about 23% of the world in the 18th century, had dropped to a mere 3% in 1947. The reason, according to Tharoor, was straightforward: the rise of Britain at the expense of India through its plundering of India's resources for nearly 200 years. The ramifications of it were poverty, illiteracy and economic backwardness. For these reasons, socio-economic policies of India demanded an immediate and careful attention. In this context, education is the most crucial factor for any country to progress. Specifically, higher education has been an incredibly vital factor that helps in creating a skilled workforce, which by innovation and creativity then plays a decisive role in uplifting economic growth, increasing life expectancy, improving the standards of living besides solving the other problems. *The British started the higher education system of India in 1857 with the establishment of three universities- Calcutta, Bombay, Madras and 28 affiliated Colleges* (Nature, 2015).

India had only 18 universities when British left in 1947, and the total enrolment of students was less than 0.2 million. (Choudhury, 2008). Also, there was insufficient awareness for educating the mass people. Higher education sector largely remained open only to a certain privileged secton of the urban elite.

After Independence, India flourished under the leadership of Pt. Jawaharlal Lal Nehru, who envisaged the future of Indian education system. Nehru setup various institutes across India such as IITs, and AIIMS(s) for the world-class research and training workforce. Later, the government declared these institutes as "**Institute of National Importance**[1]".

India has various educational institutional bodies to govern Institutions, Universities, Colleges such as U.G.C (University Grants Commission), M.H.R.D (Ministry of Human Resource and Development), and A.I.C.T.E (All India Council for Training Education).

EXPANSION OF HIGHER EDUCATION SYSTEM

The establishment of educational institutions after independence was essential because the literacy rate was only 18%. The enrolment in higher education was about 0.39 million in 1950. Thus, there was a need to increase the number of institutions. From 1950-1990, Indian educational infrastructure underwent a significant expansion of universities and institutions. Besides the government universities, the private universities also increased rapidly with the advent of globalisation and liberalisation. However, the enrolment of students in Basic Sciences was very less as compared to other fields until 2004, leading to lower research output.

[1] http://mhrd.gov.in/institutions-national-importance

TABLE 1, GROWTH IN HIGHER EDUCATION POST-INDEPENDENCE IN INDIA

S.No	Year	No. of University	No. of College	Total
1	1950-1951	27	578	605
2	1960-1961	45	1819	1864
3	1970-1971	82	3277	3359
4	1980-1981	110	6963	7073
5	1990-1991	184	5748	5932
6	1991-1992	196	6008	6204
7	2000-2001	254	10162	10416
8	2001-2002	272	11146	11418
9	2002-2003	304	11776	12080
10	2003-2004	304	12178	12482
11	2004-2005	343	13578	13921
12	2005-2006	350	17252	17602
13	2006-2007	371	19812	20183
14	2007-2008	406	23099	23505
15	2008-2009	440	27882	28322
16	2009-2010	436	25938	26374
17	2010-2011	621	32974	33595
18	2011-2012	642	34852	35494
19	2012-2013	667	35525	36192
20	2013-2014	723	36634	37357
21	2014-2015	760	38498	39258
22	2015-2016	799	39071	39870

source: MHRD Statistics, SHTE,AISHE, 2007-2008,2015-2016,[23]

In 1950, the number of educational institutions was very less. As the economy of India in 1950 was in lousy phase, the expansion of educational institution in higher education as well as higher secondary, and the primary was necessary to uplift the economy besides other reasons. From 1950 -2016, the total number of institutions has increased from 605 to 39870. In terms of Universities, from 27 to799 and colleges from 578 to 39071.

As **Table 1** shows, in 2016 there are about 799 universities, 39071 colleges and 12276 Stand-alone Universities. Out of this, 799 Universities, 277 are maintained privately. The institution of National importance was about 75, in 2016 (90 in 2017) (MHRD, 2015-2016).

[2] (MHRD, 2015-2016, pp. 64,68)
[3] (GOI(MHRD), 2007-2008, p. 21)

TABLE 2, AISHE2015-2016, MHRD STATISTICS

Higher Education	University	Central Open University	1
		Central University	43
		Deemed University-Government	32
		Deemed University-Private	79
		Institution Under State Legislature Act	5
		Institute of National Importance	75
		State Private University	197
		State Public University	329
		State Open University	13
		State Private Open University	1
		Deemed University-Government Aided	11
		Others	13
		Total	799
	Colleges		39071
	Stand-alone Institution	Diploma level technical	3845
		PGDM	431
		Diploma level Nursing	3114
		Diploma level Teacher training	4730
		Institute under ministries	156
		Total	12276

ENROLMENT IN HIGHER EDUCATION

The enrolment of students in higher education has increased from 0.39 million (390,000) in 1950-1951 to 4.85 million (48, 573, 83) in 1980-1981. From 1980-1981 to 2008-2009, it hiked from 4.85 million to 18.5 million. From 2008-2009, it showed growth by 1.5 times to 27.49 million. From 27.49 in 2010-11, it increased to 34.58 million in 2015-2016 by the growth rate of 18.5%.

TABLE 3, S.T.H.E 2008-2009, AISHE 2015-2016, SELECTED YEARS

Year	Male	Female	In Numbers	In Million
1950-1951	351222	44916	3,96138	0.39
1960-1961	795014	167242	9,62256	0.96
1970-1971	2587967	723770	33,11737	3.31
1980-1981	3561620	1295763	48,57383	4.85
1985-1986	2537545	1067484	36,05029	3.6
1990-1991	3368610	1556258	49,20000	4.92
1995-1996	4210398	2363607	65,74005	6.57
2000-2001	5443829	3182503	86,26332	8.62
2005-2006	8831748	5491818	14,323,566	14.32
2008-2009	11227810	7272515	18,500,000	18.5
2010-2011	15466559	12033190	27,499,749	27.49
2011-2012	16173473	13010858	29,184,331	29.18
2012-2013	16617294	13535123	30,152,417	30.15
2013-2014	17495394	14840840	32,336,234	32.33
2014-2015	18488619	15723018	34,2116,37	34.21
2015-2016	18594723	15990058	34,584,781	34.58

Source: S.T.H.E 2008-2009, AISHE 2015-2016, Selected Years

Note: There are few discrepancies between the two tables, only selected years data were collected because of unavailability of the data of specific years, overall trend of both data is nearly the same

TRENDS IN HIGHER EDUCATION AND ENROLMENT OF STUDENTS

FIGURE 1: TREND OF INSTITUTIONS IN HIGHER EDUCATION IN INDIA

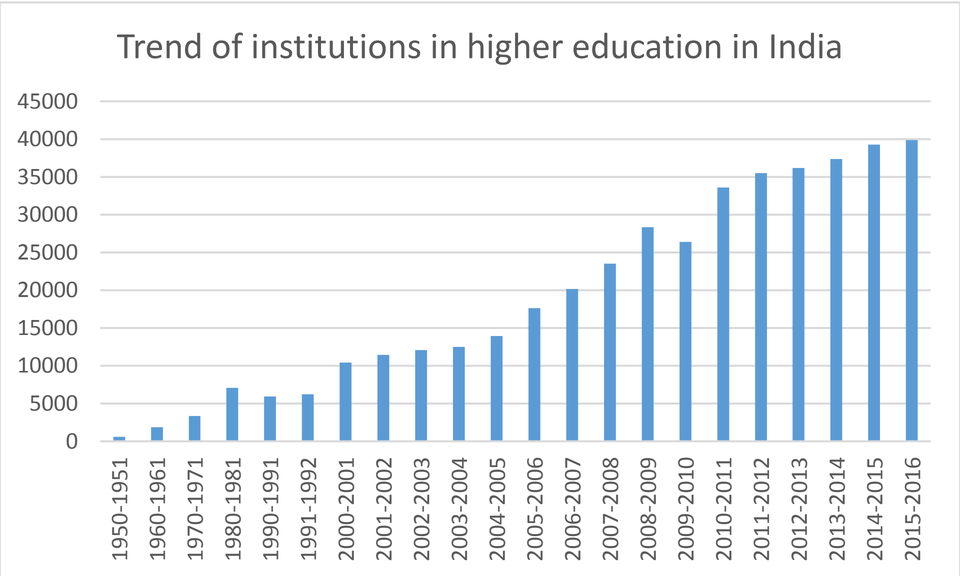

Fig:1, source: S.T.H.E 2008-2009, AISHE 2015-2016

As is obvious from the trend, with the growth of Institution in Higher education, there has been a significant change in the trend of the enrolment of students in higher education. The trend is somewhat similar to the higher education in science, where the enrolment in 1950-1951, was 127168 students, and 725358 in 1986-1987 and 1000,000 in 1996. During 1996, the enrolment declined. The reason for this decline was that most students were not seeking basic sciences but professional courses in science. Thus, admission to medical, engineering and professional education increased significantly while the scenario in basic sciences remained bleak. Students with better rankings and privileges were found to pursue careers in technical disciplines that ensured decent employment and better salaries.

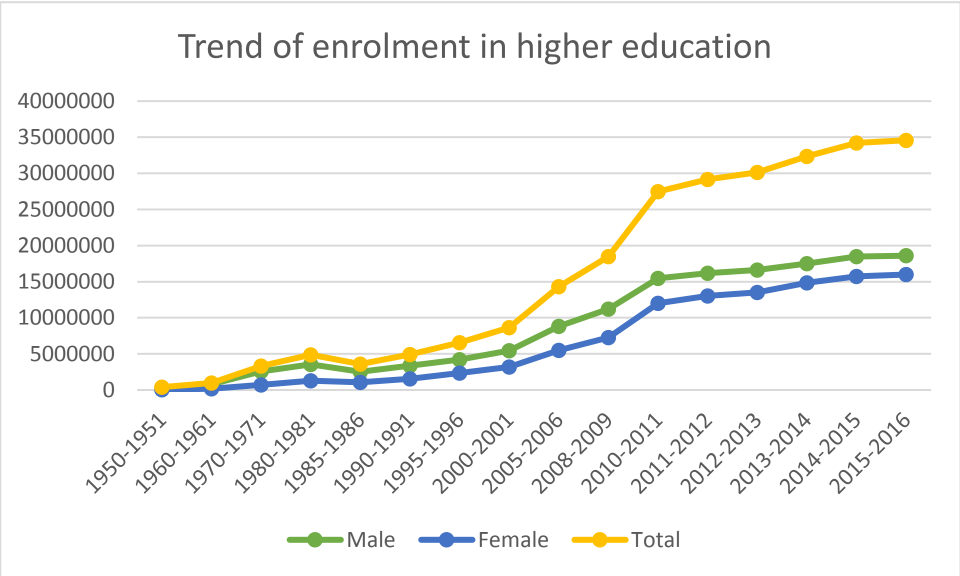

FIGURE 2: TREND OF ENROLMENT IN HIGHER EDUCATION

source: S.T.H.E 2008-2009, AISHE 2015-2016

STUDENT ENROLMENT BY PROPORTION

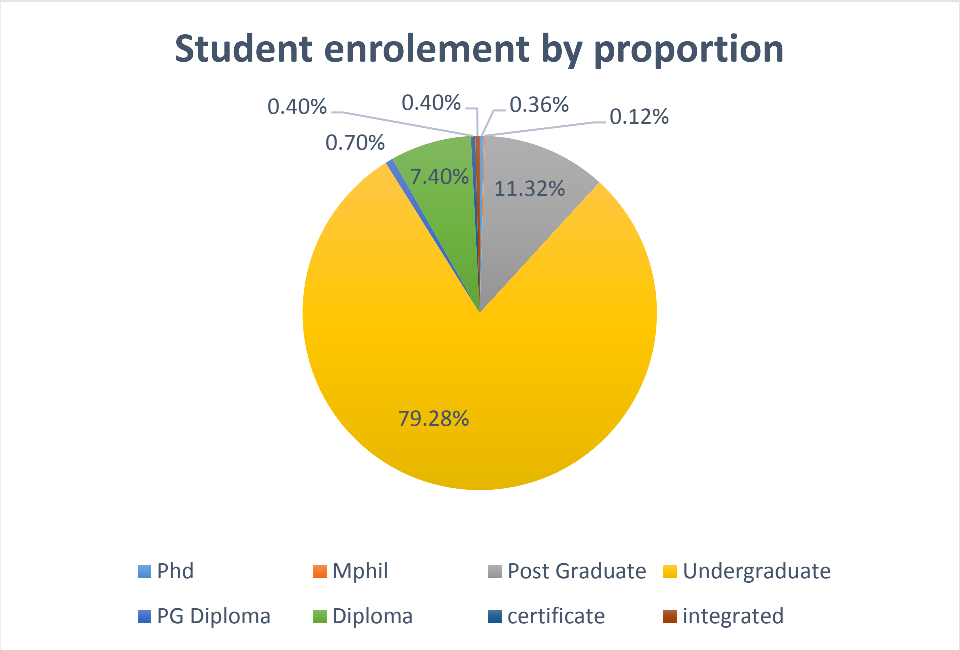

FIGURE 3: STUDENT ENROLMENT BY PROPORTION

(Source: AISHE 2015-2016, MHRD, Statistics, T-43)

The overall student Enrolment in higher education has been organised in eight components namely Ph.D., MPhil, Postgraduate, Undergraduate, PG Diploma, Diploma, Certificate and Integrated Programmes. The percentage value of student enrolment in these is shown in (Fig5). Among total students, undergraduate enrolment is the highest in numbers across India. The share of undergraduates from the total enrolment of 34 million (3, 45, 84,781 students) is about 2, 74, 20,450 students about 79.3%. Nevertheless, at the second comes the Postgraduate student that covers 39, 171, 56 (3.9 million) students about 11.3%. About 7.4% share is in the enrolment of Diploma students 25,491,60 in numbers. A number of students enrolled in Integrated PhD is about 155422. Besides, the small proportion of students in Certificate courses, PG Diploma which in numbers are 144060 and 229559, comprise approximately, 0.4% and 0.7% respectively. What is even more stressing is that India constituted by a population of 1.3 billion has less than 0.5% of PhD (1, 26, 451) and M.Phil. (42,523).

PRIVATE SECTOR ENROLMENT

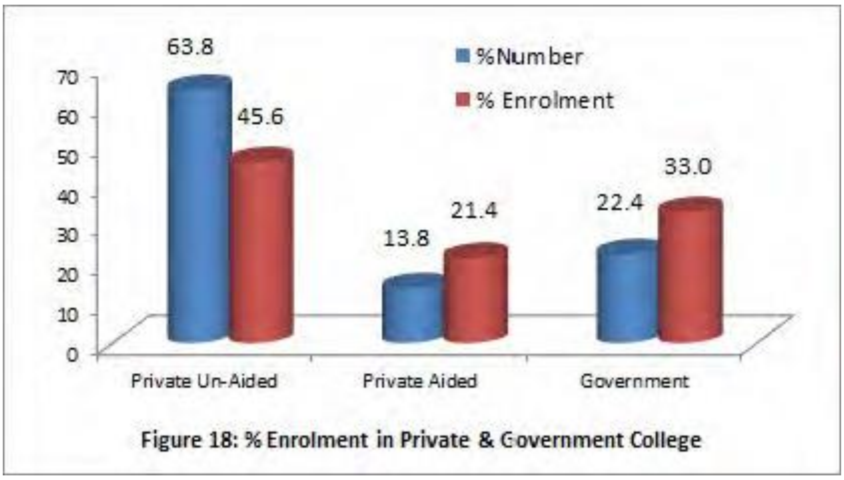

FIGURE 4: PRIVATE SECTOR ENROLMENT

source: AISHE 2016, MHRD Stat

The total contribution of Private University in the higher education sector is more than 78%. However, the subscription of it is only of 68% of the total enrolment.

TABLE 4, SOURCE: AISHE 2016, MHRD STATISTICS

Type of Colleges	Private unaided	Private Aided	Government
Number	22755	4924	7988
Enrolment	11729224	5516630	8485309

TREND OF UNIVERSITY TYPE DURING LAST SIX YEARS

The number of Private universities between 2010-2011 and 2015-2016 has increased from 87 to 197. On the other hand, the state/public university number has increased very slowly from 281- 329.[4]

Globalisation and liberalisation of the economy resulted in a shift of public sector into the private sector, as an effect, a number of private universities and colleges has grown tremendously. It leads to increase in expenses of education as private firms are investing on

[4] AISHE2015-2016, table; Number of universities by type pg. no: 179

infrastructure and paying their employees lucrative salaries for the exchange of quality teaching. Consequently, it has become the trend of offering expensive higher education by private universities and colleges. However, only the very few lead to creating desirable results in the end. Most universities and colleges fail miserably in term of both research and teaching even after expensive fees. On the other hand, the number of coaching classes for preparation of entrance level exams such as JEE MAINS, AIIMS, CAT is increasing.. Rich people can afford expensive education for their children while poor people remain dependent on government schools. The clumsy system of government schools leads to low productivity and creativity in children. It leads to inequality in people. This is mainly due to lack of infrastructure and qualified staff. Further, as Neoliberalism advocates the idea of "free markets" the market with the minimum state intervention due to which there is a shift of public sector to private sector. As a result, private education becomes expensive, not within reach of poor people. The poor people who are only dependent on government schools and colleges for their higher studies. Since in India, the informal sector covers more than 90% of the total workforce of India. Thus, it is imperative to give opportunities to the poor, leading to reducing of inequality in India.

PROBLEM WITH THE UNIVERSITIES

There was immense growth from 1995- 2004. The universities were imparting knowledge to the Indian students, and the only outcome was that students were looking for quick jobs and other careers. Few were and are doing excellent research, such as Hyderabad University, Jawaharlal Nehru University and Delhi University. It is also to be noted that enrolment in basic/natural sciences was less; output from these universities was not satisfactory.

Table 2.4: Enrolment in higher education (Graduate+) by level of education (per cent)

Fields of study	Graduate			Postgraduate			Total enrolments		
	UGC* 1995–96	UGC 2000–01	NCAER** 2003–04	UGC 1995–96	UGC 2000–01	NCAER 2003–04	UGC 1995–96	UGC 2000–01	NCAER 2003–04
Science	27.9	30.2	33.1	36.5	38.3	41.4	28.7	31.0	34.6
Natural science	18.4	19.2	20.3	23.0	26.6	11.5	18.9	20.0	18.7
Engineering	5.9	7.3	7.9	5.4	4.3	26.4	6.0	7.0	11.3
Medicine	2.9	3.1	4.1	5.4	4.3	2.3	3.0	3.2	3.8
Agriculture/Veterinary	0.7	0.7	0.9	2.7	2.1	1.1	0.9	0.8	0.9
Arts	47.9	45.9	49.9	47.3	45.7	44.3	47.7	45.9	48.9
Commerce	17.4	18.4	14.2	12.2	13.8	5.7	17.0	17.9	12.6
Others	6.8	5.5	2.7	4.1	3.2	8.6	6.5	5.2	3.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Number (million)	5.91	7.50	7.76	0.74	0.94	1.73	6.65	8.44	9.49

FIGURE 5: ENROLMENT IN GRADUATION AND POST-GRADUATION (FROM 1996-2004).

(Source- Indian Science Report (ISCER); Enrolment in graduation and post-graduation.)

It is clear from the table that even after the humongous increase in a number of universities, the enrolment of graduate has increased from 18.4% to 20.3% in natural science and increased in other fields, but the trend in natural science shows a decline in postgraduate from 23% to 11.5%. With the total enrolment in post-graduation 17.3 million in 2003-2004, which was double compared to 2000-2001. Out of these, not more than 1% pursue Doctorate. As Balaram (2002) mentions, the number of students opting for research in pure sciences has sharply decreased.

Also, as stated by Aggarwal[6], there was a proliferation of the graduate and postgraduate students in science. However, the overall enrolment in science had dropped. At the undergraduate level, it had decayed from 33.32% in 1971 to 21.7% in 1997; and postgraduate from 26.1% in 1971 to 22.2% in 1997.

The decrease of enrolment in science broadly consists of two factors. Firstly, the students had lost interest in pure science with the establishment of IITs, IIMs, AIIMs, during 1950-2000, there was no such institute of science existed at the scale of the institute of national importance in India. Hence, students started pursuing engineering and other fields. Secondly, the majority of brilliant students after liberalisation and globalisation migrated to U.S.A and other countries for the better career opportunities—a pervasive trend often popularly termed as 'brain-drain.'

Table 1-07.01: Asian recipients of US doctorates in various fields (1985-2005)

Field	Asia	China	India	Taiwan	S. Korea
S&E	130,426	41,677	18,712	19,187	18,872
Engineering	48,166	12,784	8,172	8,816	7,273
Science	82,260	28,893	10,540	10,371	11,599
Agricultural sciences	5,313	1,313	434	709	728
Biological sciences	20,973	9,957	2,668	2,658	2,132
Computer sciences	5,850	1,360	1,515	970	745
Earth & atmospheric Sc.	2,947	1,345	243	388	366
Mathematics	6,236	2,692	575	739	829
Medical/other life sciences	4,026	813	727	753	413
Physical sciences	19,735	8,934	2,479	2,234	2,429
Psychology	2,005	297	238	297	318
Social sciences	15,175	2,182	1,661	1,623	3,639
Non-S&E	22,691	2,668	2,911	3,727	5,267
All fields	**153,117**	**44,345**	**21,623**	**22,914**	**24,139**

FIGURE 6: MIGRATION OF INDIAN PHD STUDENTS IN U.S (SOURCE: SCIENCE AND TECHNOLOGY 2008)[1]

[6] (Aggarwal, 2006)

As the table depicts the numbers of PhD graduate from various countries that migrate to the US, for the better career. India was undergoing a remarkably bad phase during that time.

Table 1-07.02: Flow of students from China and India to USA and vice-versa

Year	China			India		
	No. of students	% of foreign students in US	Number of US students to China	No. of students	% of foreign students in US	Number of US students to India
1994/95	39,403	8.7	1,257	33,537	7.4	409
1995/96	39,613	8.7	1,396	31,743	7.0	470
1996/97	42,503	7.8	1,627	30,641	6.7	601
1997/98	46,958	9.8	2,116	33,818	7.0	684
1998/99	51,001	10.4	2,278	37,482	7.6	707
1999/00	54,466	10.6	2,949	42,337	8.2	811
2000/01	59,939	10.9	2,942	54,664	9.9	750
2001/02	63,211	10.8	3,911	66,836	11.5	627
2002/03	64,757	11.0	2,493	74,603	12.7	692
2003/04	61,765	10.8	4,737	79,736	13.9	1,157
2004/05	62,523	11.1	n/a	80,466	14.2	n/a

Figure 7: FLOW of students from china, India to us (vice-versa),(Source: Science and Technology 2008)

As the table shows, China and India are the primary players of contributing researcher to overseas countries; there was a sharp rise of migration of Indian students in the USA from 2000-2005. Also, there has been a trend of mass migration of IIT graduates and others (known as "Brain drain.", as already discussed previously); which has been voiced by many politicians, educationist, scientist and led government official to reform the education policies.

Moreover, the scientific workforce that was required for national laboratories of India such as DST, DAE, DRDO, NCLA, DOS, CSIR, and ISRO, etc. It was not possible from the university system due to some fundamental problems in the university system such as inadequate financial resources, outdated curriculum, lack of state of the art infrastructure, lack of highly qualified staff.[9]

It is also well brought out in (Dube, 2016):

> *Moreover, the UGC stamped talent was not considered good-enough for the newly established high profile research institutes, further worsening the relations between the two parallel systems and leading to even more concrete professionalisation of*

[9] (Khare, 2016)

science. This could perhaps also be one of the reasons of the limiting reach of science temper among the laymen. From then till now, UGC faces a financial crisis and perhaps a moral crisis too, because it is almost exclusively public funded and regarding nation-building process its contribution was not producing visible changes in the nation. In a continued ignorance, the UGC has now degraded to a mere examining and certificate issuing body while the research institutes lead Indian science forward. (pp. 65)

SUMMARY

Education is the most crucial factor for developing the humankind, society and country. India had only 18 universities when British left India in 1947, and the total enrolment of students was less than 0.2 million. It was essential for an infant Independent India to enrol the students in the higher education sector demanding an expansion of the educational infrastructure. From 1950 -2016, the total number of institutions has increased from 605 to 39870. Regarding Universities, from 27 to799 and colleges from 578 to 39071. The enrolment of students as of 2016. The share of undergraduates from the total enrolment of 34 million (3, 45, 84,781 students) is about 2, 74, 20,450 students about 79.3%, 11.3% of postgraduate students and less than 0.5% is the M.Phil. and PhD students. The enrolment of students in higher education has increased from 0.39 million (390,000) in 1950-1951 to 4.85 million (48, 573, 83) in 1980-1981. From 1980-1981 it hiked from 4.85 million to 34.58 million in 2015-2016. There was a proliferation of the graduate and postgraduate students in science. However, the overall enrolment in science had dropped. At the undergraduate level, it had decayed from 33.32% in 1971 to 21.7% in 1997; and postgraduate from 26.1% in 1971 to 22.2% in 1997. The trend in natural science shows a decline in postgraduate from 23% to 11.5%. With the total enrolment in post-graduation 17.3 million in 2003-2004, which was double compared to 2000-2001. This low enrolment in Science leads to low scientific research output. The decrease of enrolment in science broadly consists of two factors. Firstly, the students had lost interest in pure science with the establishment of IITs, IIMs, AIIMs, during 1950-2000, there was no such institute of science existed at the scale of the institute of national importance in India. Hence, students started pursuing engineering and other fields. Secondly, the majority of brilliant students after liberalisation and globalisation migrated to U.S.A and other countries for the better career opportunities. Mainly the skilled workforce of India including scientist and engineers started migrated to overseas countries. As the universities have exponentially grown from 1950-2004 but, the scientific workforce that was required for national laboratories of India such as DST, DAE, DRDO, NCLA, DOS, CSIR, and ISRO, etc. It was not possible from the university system due to some fundamental problems in the university system such as inadequate financial resources, outdated curriculum, lack of state of the art infrastructure, lack of highly qualified staff. Furthermore, with the advent of globalization and liberalization, there has been a significant increase in the private universities and colleges, which also lead to low scientific research output, only a few private universities and research institute that has been doing good research. Therefore, at some point in time different researcher, professors, educationalist and government official expressed their views to control the declining state of science education and scientific research in India by opening new scientific edifice meeting with international standards.

CHAPTER 2

THE NEED FOR IISERS

This section deals with the need of IISERs, from the perspective of documents available on the web, institutional repositories, and the people that played a role in the building of IISERs.

We have already seen above how enrolment of students in basic sciences was declining during the 2000-2005 period, leading to a slump in research activities in the universities. How was this alarming situation being taken by scientists and the government? How were they planning to manage the situation?

Universities were mostly concerned with science teaching since funds for scientific research were not adequately dispensed by the government. Funding was provided to only a few universities.

Also emphasised in (Dube, 2016)

However, suffering from financial crisis, universities could not match up with the research profile of the institutes or provide the workforce of the desired quality. World-class institutions (the IITs) were then set up to provide the workforce, and UGC was relegated to a mere examining body.

National Laboratories had been undertaking the national project based researches of India. On the other hand, research in basic sciences was primarily done in universities. Despite the sharp rise in a number of universities, there were various issues expressed by the scientific community in the 20th century (during 1990-2003) about the nature of higher education and especially related to scientific education and research. The higher education system of India had been affected, with a “fundamental problem” outlined in (Ganesh, 2015):

..the faculties that used to teach the undergraduate in colleges were not involved in scientific research. Faculties that used to carry out research (in universities or national laboratories) did not teach undergraduates. On the contrary, in western universities, the faculties that carry research, teaches the undergraduate.

“It is true that most of the breakthrough has come from universities setting abroad, in which teaching and research are intervened” (Shanbhag, 2003)

During 2005-2008, the Government of India set a new type of Institutions, which were research-based and incorporated undergraduate level teaching as well.

At present (as of 2017) India has 7 IISERs (IISER Bhopal, IISER Kolkata, IISER Mohali, IISER Pune, IISER Trivandrum, IISER Tirupati, IISER Berhampur) and one more yet to come (IISER Nagaland), 1 NISER(Bhubaneswar), 1CBS (Centre of Excellence in Basic Science). Above institutes were established for promoting research in Basic Sciences.

Despite the growth in scientific infrastructure (universities, Institutions, colleges, national laboratories) in the period of 1950-1990 including IITs, IIMs, TIFR, BAARC, CSIR labs and ISRO, set up to promote higher education sector and to elevate the research activities in India. In 1990-2003, there were significantly fewer PhD scholars and very few post-doctoral scholars in India as compared to other leading countries. The number PhD scholars in China grew from **8139 to 48740, whereas in India it grew from** approximately **3000 to** approximately **5000 during the same period**[10]. During 1998, a doctorate was awarded to 10,951 students in India of which only **3826 Students** were from basic science and 4196 from Humanities, 696 for engineering, 190 for medicine, 101 for veterinary science, and 796 for agriculture[11]**. Also, according to National Science Foundation report- Science and Engineer indicator- 2002, Science and Engineering graduates who end up completing their doctorates make about 4% of total graduates, 7% in Europe and India it is not even close to 0.4%**[13]**.** The research output of India in the field of basic sciences or open-ended research coming from numerous colleges and universities just before the birth of IISERs was below satisfactory level. Decidedly fewer students pursued basic sciences and amongst those who did choose to do science after their Higher Secondary School Examination were mostly enrolled in affiliated colleges that did not have adequate staff, resources and did not have necessary laboratory equipment. As a result, even motivated students have driven away from basic sciences. **The absence of attractive opportunities and robust Infrastructure-led to the mass migration of highly talented Indian stock of science including Scientist and Engineers.**

The system of science education was rigid at that time, and even in the best of science colleges or universities, interdisciplinary was an alien concept. It limited one's knowledge and scientific temper to particular discipline only. Consequently, the obvious output from this system was curiosity-lacking, discouraged students.

To regulate "Brain drain", the need for a new science-edifice was felt. Therefore, few professors and industrialists from Pune came up with a proposal to open a new kind of science institutes in which even at undergraduate level, one could experience the research-atmosphere and could be familiarised with the research while contributing to the development of India. Finally, came the first IISER in Pune (in 2006) and then in other subsequent parts of India. Since IISER's curriculum is very different from other science institutions and colleges, it inherently evoked questions like:

Q: How are IISERs different from other Research institutions and universities?

Q: **Why there was a need for IISERs?**

THE GENESIS OF IISERS

To study and probe these questions profoundly, first, we need to dig up the history of IISERs. It took more than ten years for IISERs to become a reality. Metaphorically, from a chemist's perspective, a reaction was started in 1996 with the starting reactant (ACST), went through many transition states (ACSTE, Centre of studies, NISc, NISER) before it finally appeared as

[10] DPR IISER MOHALI
[11] (Shukla)
[13] (Aggarwal, 2006, p. 71)

a product (IISER) in 2006. Professor Govind Swarup of N.C.R.A (National Centre for Radio Astrophysics) Pune, Prof. V.G Bhide of Pune and few Industrialist conceived an Institute for the B.S-M.S Integrated dual degree Five-year program, submitted a proposal for an “Advanced Centre for Science and Technology” back in 1996. Within the journey, central government changed, and the name of the conceived institute got changed to National Institute of Science(NISc). Finally, when the U.P.A-1 Government came to Power, IISERs came into existence. Along the journey, the original idea underwent some profound mutations too, as a shift from Science and Technology to Science can be observed in the history of IISERs’ genesis.

Prof. Govind Swarup and (late) Prof. V.G Bhide (Vice-chancellor of University of Pune) along with some Industrialists, in 1996, proposed to establish an institute, for starting, 5-year BSc-MSc course after the H.S.E schooling. They made a meticulous proposal stating the need for such a set of institutes to improve the teaching and creating a workforce for the development of the India.

The very first draft stated objectives of the proposal are as follows (paraphrased):

1. To attract the brilliant students.

2. Imparting the best possible education to students by highly skilled faculty members, and through well-equipped laboratories.

3. Infuse the qualities of leadership, entrepreneurship, and innovation in students.

4. To prepare students for a challenging career ahead.

5. To foster a contiguous relationship between Science Education and Technology, to meet the demand of challenges of the 21st century.

Reasons for opening the new Science Institute (in the proposal, paraphrased)

There was a need for revamping the science education at the Pune University by developing the stable linkages with some Industries and research institute, during 1996. On the contrary, enrolment of students in science education was in decline.

The proposal was to start AISTS as an autonomous institute within the Universities. Also, the integration of teaching with research had to be of paramount importance, with the first two years devoted to studying all subject (physics, chemistry, math, biology) and others to inculcate interdisciplinarity, followed by two years of specialisation in one subject, culminating in one year for project work.

Another formal proposal was made by (late) V.J Bhide (former vice-chancellor, at University of Pune) stating the need for establishing an autonomous “Advanced centre for Science and Technology(ACST) at Pune. It was envisioned with a total budget of Rs 65 crore over five years, and having the close linkage with universities, research institutes, and industries.

K. Alagh (the then Minister for Science and Technology(S&T), supported the proposal. After which Planning commission wrote to the DST secretary in January 1997, for giving the grant of 5 crores to University of Pune for starting work on ACST.[14]

When in December 1997, BJP defeated the I.K Gujral government, the ACST was changed to ACSTE in a meeting held by the Ministry of Human Resource Development (MHRD) in October 1999.

Despite many efforts made by Pune group to make progress in the government work, during 1999-2002, the then MHRD minister, Murli Manohar Joshi remained unresponsive with the proposal.(Article in current science- (SWARUP, 2015)[15].

In a meeting held by University Grants Commission on 9th April 2003 the UGC agreed for the establishment of institutes that for elevating the quality and research in basic science in collaboration with other scientific agencies in the 10th 5-year plan.

The commission resolved to establish the centre of studies in the integrated Science at the following locations in India.

East: At Bhubaneshwar in the proximity of Utkal University

West: At Pune in the proximity of University of Pune

North: At Allahabad in the proximity of Allahabad University

South: At Chennai in the proximity of Anna University

In an official letter from V.S Pandey (then Joint-Secretory, MHRD) sent to Dr Arun Nigavekar (chairman of the commission, in the University of Pune) on June 9, 2003 it was informed that the U.G.C would establish four **Centre for Studies in Integrated Science (CSIS)**. Also, that these proposed centres would be established under the section 12(c)(c)(c) of the U.G.C Act, as was proposed by Dr Govind Swarup and (late) Prof. V.G. Bhide during 1994 as an Advanced Centre for Science and Technology (ACST).

Another official letter by Arun Nigevekar ((chairman), University Grants Commission) to Dr Ashok Kirloskar (vice chancellor) on July 23, 2003, stated that these centre(s) of Studies were to be established in different places of India such as Pune, Chennai, Bhubhneshwar, Allahabad. Now, these centres of Studies would be called as **National Institute of Science(NISc)**, under the subject of the establishment of the National Institute of Science- a UGC initiative in collaboration with other scientific agencies in the Tenth-five-year Plan. Initially, these NISC would have budget 50 crore rupees (**UPA-1 increased this budget ten-fold to 500 crore rupees**) for the initial five years. To assure the provision of 100 Crore for this activity planned in the Tenth plan, the U.G.C had approached Planning commission for an additional 100 crores for this project in the period of the Tenth plan. Each NISC would be provided with a fund of INR 25 crores each.

These NISCs would be established as an autonomous institution under clause 12(c)(c)(c) of the (U.G.C) act in close linkage with various science agencies such as DST, ISRO, DAE, DBT, CSIR. It was anticipated that the University of Pune would recognise the NISC as an

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[14] (SWARUP, 2015)

[15] Refer – "Genesis of IISERs" in Current Science, Vol. 109, No. 5, 10 September 2015, pg. 841

autonomous institution and would provide full academic, administrative, financial freedom for the operational purpose.

From 1999-2004, there was NDA government at the centre. After the UPA-1 government came to power in 2004 following elections in August 2004, the Pune group wrote to Arjun Singh, the then MHRD minister, and Kapil Sibal, the then minister for S&T, requesting an early approval for the ACST. In a meeting, which held at New Delhi on 12th October 2004, chaired by Arjun Singh, for discussing the plan of ACST, the government agreed to set up several Centre of Excellence in Basic Science.

Finally, (late) V.G Bhide of University of Pune sent a letter to Kapil Sibal, Minister-MHRD on March 7, 2005, reaffirming about the decision taken by the cabinet to establish the **National Science Education and Research Institute** at **Pune** and **Kolkata** that was proposed as (Advanced Centre for Science and Technology) back in 1996.

Another letter sent by Kinetic by Arun Firodia (Chairman) to Govind Swarup on March 9, 2005, greeting Govind Swarup and prof. V.G Bide that government gave the grant of 500 crores and 100 acres of land to establish the National Institute of Science Education and Research at Pune. The letter also expressed gratitude that this was the output of several efforts made by him in seven years. Later, the name NISER was changed to IISER. Finally, **IISER-Pune and IISER-Kolkata were established in 2006**.

HOW ARE IISERS DIFFERENT FROM THE CONVENTIONAL SCIENCE COLLEGES, UNIVERSITIES & RESEARCH INSTITUTES?

IISERs are different from other Science education institution because of the integration of research with the science teaching, which other science institutes have not had especially, the universities. IISERs have recruited a highly qualified staff and meet international standards. Science colleges and universities were in abundance, but their primary motive was only to impart science education with little research outcome due to the inadequacy of financial resources. Whereas, research institutes were not concerned with the teaching. Thus there was a duality (Dube, 2016)[18] in the Infrastructure that existed pre-IISERs. The IISERs, as the name suggest "Indian Institute(s) of Science Education and Research", focus on both: Science and Research. Their genesis was done with the presumption that they shall create the understanding of science subjects, right from the undergraduate to the active environment of research.

IISER allows its undergraduate students to experience the hands-on experience of doing experiments and using of sophisticated laboratory equipment in biology, chemistry, and physical sciences. Advanced instruments become very handy to the trained students and furnish themselves more even in their master's time and during the summer project. Some

[18] pp. 65 - *Obviously, there have been some cases of universities matching up with institutes and support being given to some of the universities but these cases are too few and very recent to be able to erase the "dualism" that Indian science bears.*

undergraduate students end up publishing research paper within five years, which provokes students to join PhD. This is completely unheard of in the University system. IISERs are markedly different from other science institutes in aspects of research, academic, financial and in term of its functionality. IISERs research infrastructure blueprint is in such a way that it allows their faculty member to use an abundant research fund.

Moreover, research agencies such as DST, CSIR, and BAARC, and other abroad agencies, also fund faculty for their research and other sponsored research projects. On the academic front, IISERs curriculum is designed in such a way that it can foster maximum outcome of the student in particular subjects. Whereas conventional science institutes students were allowed to do an undergraduate degree in specific subjects only, such as B.Sc. chemistry, physics, biology, mathematics, which limits one understanding, interdisciplinary science is promoted in IISERs.

As each IISER is an autonomous Institution, it can further make rules to maximise development. Every IISER is a little bit different from other IISERs in academic functioning. IISERs are known to be flexible with their functioning whereas other educational institutes are rigid in their functioning and follow nearly same curriculum over the years.

After the establishment of IISERs not only the Research output increased, there has been an impressive rise in enrolment of students in science in the last five years.

The number of Indian students that go for the higher education in science has increased. However, there is also an increase in domestic science enrolment at post-graduate level. This trend would not have taken place if new kind of Science Institutions did not emerge.

TABLE 5: ENROLMENT OF POSTGRADUATE STUDENTS IN INDIA INDIFFERENT DISCIPLINE FROM (2012-2016)

Enrolment in important programmes at Post Graduate Level in Regular mode of education					
Year	M.A.-Master of Arts	M.B.A.- Master of Business Administration	M.Com.-Master of Commerce	M.Sc.-Master of Science	M.Tech. - Master of Technology
2011-12	573528	356286	152228	377001	159561
2012-13	662839	392587	179813	414316	209720
2013-14	674447	392937	193373	431723	260370
2014-15	767027	409432	222709	481330	289311
2015-16	878677	416325	271266	519159	257361

Source: AISHE2015-2016,MHRD,Statistics

TABLE 6: ENROLMENT OF UNDERGRADUATE STUDENTS IN INDIA FROM (2012-2016)

Enrolment in important programmes at Under Graduate Level in Regular mode of education					
Programme	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
B.A.-Bachelor of Arts	6027027	7898579	9099473	9860520	9651891
B.Sc.-Bachelor of Science	2403146	2947052	3579526	4299538	4618172
B.Com.-Bachelor of Commerce	2364094	2810308	3117265	3338111	3422312
B.Tech.-Bachelor of Technology & B.E.-Bachelor of Engineering	3271286	3775488	4336149	4254919	4203933
B.Ed.-Bachelor of Education	436875	509355	559028	657194	514518
B.C.A.-Bachelor of Computer Applications	381583	408739	421191	432341	426229
B.B.A.-Bachelor of Business Administration	267375	292838	317024	343237	349667
L.L.B.-Bachelor of Law or Laws	156546	192168	240419	283231	300716
B.Pharm.-Bachelor of Pharmacy	127247	142630	174820	183695	195178
B.Sc.(Nursing)-Bachelor of Science in Nursing	126839	156107	176781	179496	191612
M.B.B.S.-Bachelor of Medicine and Bachelor of Surgery	110022	144504	160402	170406	191040

Source : AISHE2015-2016

As table shows, there is a similar trend in both Postgraduate and Undergraduate enrolment. Enrolment in science in both programs is second only to Arts. There has been an increase of enrolment in the students of science after the establishment of IISERs.

SUMMARY

Universities were mostly concerned with science teaching since funds for scientific research were not adequately dispensed by the government. Funding was provided to only a few universities. (the need for IISERs) There were limited opportunities in India, which in turn becomes the cause that brilliant students start moving to abroad for their brighter future ahead, remaining students prefer engineering stream or else other than science because of high employment. According to National Science Foundation report- Science and Engineer indicator- 2002, Science and Engineering graduates who end up completing their doctorates make about 4% of total graduates, 7% in Europe and India it is not even close to 0.4%.(13)

The absence of attractive opportunities and robust Infrastructure led to the mass migration of highly talented Indian stock of science including Scientist and Engineers. The system of science education was rigid at that time, and even in the best of science colleges or universities, interdisciplinarity was an alien concept.

Prof. Govind Swarup and (late) Prof. V.G Bhide (Vice-chancellor of University of Pune) along with some Industrialists, in 1996, proposed to establish an institute, for starting, 5-year BSc-MSc course after the H.S.E schooling. Finally, IISER-Pune and IISER-Kolkata were established in 2006. (The Genesis of IISERs)

IISERs are different from other Science education institution because of the integration of research with the science teaching, which other science institutes have not had especially, the universities. IISERs have recruited a highly qualified staff and meet international standards. Science colleges and universities were in abundance, but their primary motive was only to impart science education with little research outcome due to the inadequacy of financial resources. The IISERs, as the name suggest "Indian Institute(s) of Science Education and Research", focus on both: Science and Research. Their genesis was done with the presumption that they shall create the understanding of science subjects, right from the undergraduate to the active environment of research. IISERs are known to be flexible with their functioning whereas other educational institutes are rigid in their functioning and follow nearly same curriculum over the years.(How are IISERs different from the conventional science colleges, universities & research institutes?) Some **undergraduate students end up publishing research paper** within five years, which provokes students to join PhD. This is completely unheard of in the University system. IISERs are markedly different from other science institutes in aspects of research, academic, financial and in term of its functionality.

CHAPTER 3

NATURE PUBLICATION & ANALYSIS

NIRF RANKING (IISERM-52 RANK)

The NIRF (National Institute Ranking Framework) rankings are based on various factors such as:

1. Teaching, Learning, and Resources,
2. Research and Professional Practice,
3. Graduation outcome,
4. Outreach and Inclusivity
5. Perception[19]

The analysis was done amongst Universities, Institutes of Science and engineering, and colleges, which was done in May 2017. IISER Mohali scored 52nd Rank[20], which was third among the five IISERs. Indeed, it is a good score for a decade old institute. However, on analysing with other IISERs' NIRF ranking. It was found that IISER Mohali lacks industrial collaboration and consultancy research which are two major areas that can significantly improve institute ranking. Vivek Kumar Singh[21] has worked upon the data regarding the publication of the five fully operation IISERs, data collected from 2010-2014, i.e. IISER Pune, IISER Kolkata, IISER Mohali, IISER Bhopal, IISER Thiruvananthapuram. The total publication comes out to be 2340. Whereas, respective publication was 673, 871, 516, 275, 232 respectively. The analysis was done on 7 May 2015, using http://webofknowledge.com, "**the recent analysis was done on 8 Oct 2017 from 2006-2017, the total unique publication of IISERs was 5682 and IISER Pune 1796, IISER Kolkata 1728, IISER Mohali 806, IISER Bhopal 989, IISER Thiruvananthapuram 595 respectively**".

[19] To know more about methodology of NIRF Ranking, visit, https://www.nirfindia.org/Parameter
[20] https://www.nirfindia.org/OverallRanking.html
[21] (Singh V. K., 2016)

NATURE INDEX ANALYSIS

The research papers in the journal of nature are considered to be of paramount importance because the acceptance rate of this journal is less than 10% and having the very high impact factor of more than 40[22]. Therefore, publishing in this journal brings any institute on the global scientific research map.

The global ranking of Top Institutes of India from 1 July 2016- 30 July 2017 are following based on WFC, out of 500 institutions worldwide. The data was collected from the https://www.natureindex.com/ for the analysis.

IISc- 34, IITs- 49, CSIR- 74, IISERs- 119, TIFR- 283

TABLE 7: TREND OF WFC-SCORES OF IISERS IN TOP FOUR CONTRIBUTORS OF INDIA IN SCIENCE RESEARCH

Institutes	CSIR	IISc	IISERs	IITs
2012	106.22	70.88	50.97	126.84
2013	117.33	84.63	58.72	130.49
2014	136.48	94.6	77.94	175.64
2015	119.8	85.45	78.67	162.59
2016	125.19	84.74	91.65	160.62

[22] "The publications are characterised by the three parameters, AC- Article count, FC- Fractional, WFC- weighted fractional count.
AC- a count of one is given to an institute or country, if one or more author of the research article is from that institution or country, regardless of how many of co-author are from that institution or country.
FC- It is the fractional count that takes into account, the percentage of authors from the institutes per article. For calculation of the FC, all authors are considered to have contributed equally to all article. The maximum combined FC for any article is 1.0.
WFC- the weighted fractional count (WFC) is the modified version of FC in which fractional counts for an article from specialist astronomy and astrophysics journal have been down-weighted. For more information, visit the link"

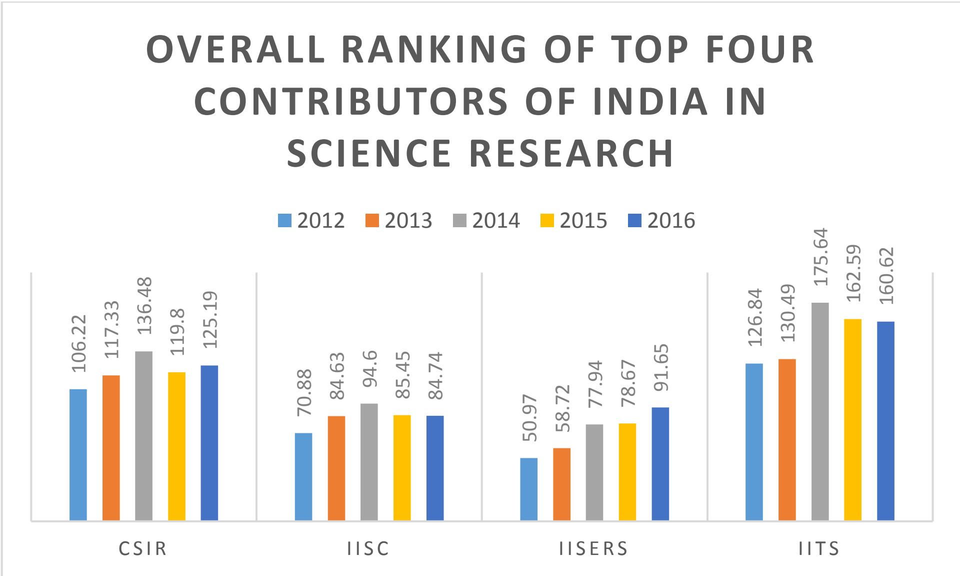

FIGURE 8: OVERALL RANKING OF TOP FOUR CONTRIBUTORS OF INDIA IN SCIENCE RESEARCH

It is interesting to observe that during the last five years IISERs contribution in nature has been significantly increasing. In 2016 the collective work done by all IISERs was impressive. They surpassed IISc and scored the third Rank, which is a big achievement for IISERs. The IISERs in question were established in 2006-2008, whereas IISc was established on 27 May 1909.

The below tables are of overall ranking of IISERs based on WFC score which is based on Physical science, Chemistry, Life Science, and Environmental Science.

Ranking of IISERs for 1 July 2016 – 30 July 2017, WFC-2017

TABLE 8: OVERALL RANKING OF IISERS

IISER	AC	FC	WFC
IISER Bhopal	59	21.17	20.77
IISER Kolkata	45	11.46	10.30
IISER Mohali	28	11.24	10.73
IISER Pune	113	28.73	27.48
IISER TVM	24	13.57	13.56

IISER Pune – 27.48, IISER Bhopal – 20.77, IISER TVM – 13.56, IISER Mohali – 10.73, IISER Kolkata – 10.30

(Note- The rankings are all based on WFC. The remaining table of overall ranking is in appendix)

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WFC SCORE RANKING OF INDIVIDUAL IISERS AMONG 398 INSTITUTES AND MUTUAL COMPARISON.

It is noteworthy that in terms of NIRF ranking of the top 100 institutes in India, IISER Bhopal secured 98th rank while IISER TVM was not on the list. However, according to international Nature Index, IISER Bhopal ranks second, and IISER TVM is third.[23]

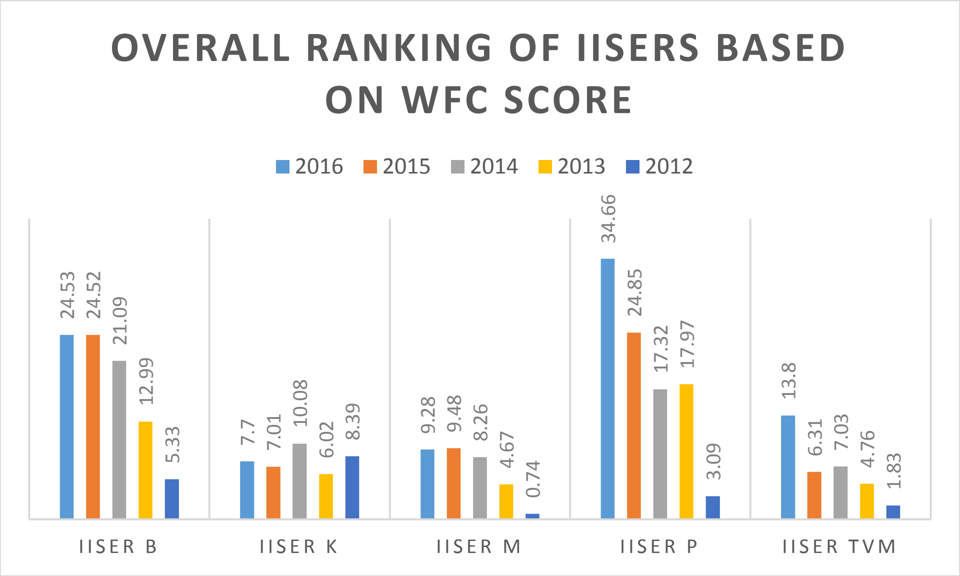

FIGURE 9: OVERALL RANKING OF IISERS

Fig:11, source: NATURE Publication data

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[23]International Nature Index ranking is solely based on number of publications in Nature, while NIRF ranking is based on various parameters.

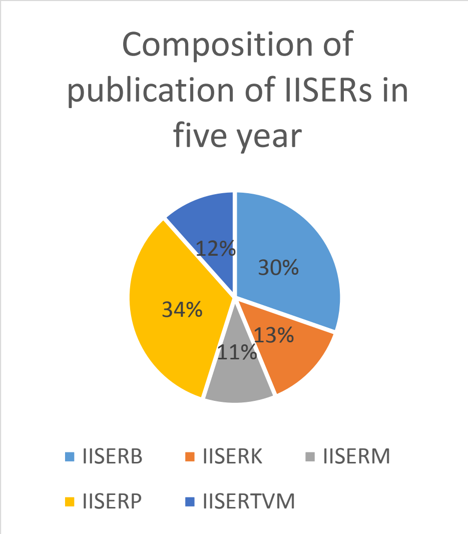

FIGURE 10: COMPOSITION OF PUBLICATION OF IISERS

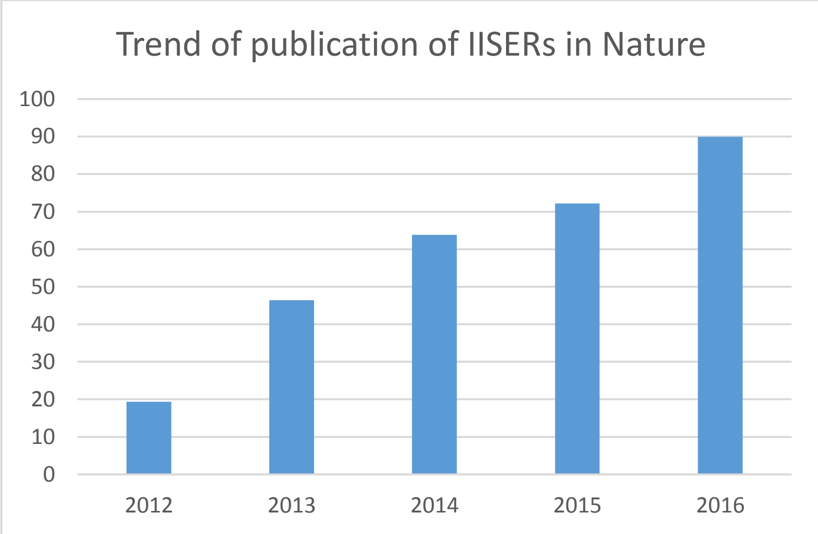

FIGURE 11: TREND OF PUBLICATION OF IISERS IN NATURE DURING 2012-2016

The percentage shares of each IISER in the five years of the collective number of Publications in Nature (from IIISERs) are IISER Pune(34%), IISER Bhopal(30%), IISER Kolkata(13%), IISER Thiruvananthapuram(12%), IISER Mohali(11%). It is affirming to find that the number of annual publications in Nature from IISERs is linearly increasing.

In terms of Publication in Nature

Individual IISER WFC score of different subjects

1 July 2016-30 July 2017

TABLE 9:INDIVIDUAL IISER, WFC SCORE OF DIFFERENT SUBJECTS

WFC	IISER-B	IISER-K	IISER-M	IISER-P	IISER-TVM
Chemistry	19.54	5.16	2.67	20.77	11.42
Physical Science	0.23	3.88	**5.16**	**6.11**	1.54
Life Science	1	1.06	**2.90**	0.66	0.60
Earth Ev. Sc.	Nil	0.20	Nil	1	Nil

In the previous year, the Biology department of IISER Mohali performed the best amongst the Biology departments of the IISERs. The physics department in IISER Mohali too is a close second.

IISERM, Bio – 2.90, Physical Science – 5.16

Five-year subject wise comparison among IISERs based on Nature Index rank, the top three institute will be given points based on WFC score for the plot.

WFC of Individual IISERs among IISER of Physical Science

Table 10: WFC of Individual among IISER in Physical Science

WFC	IISER- B	IISER- K	IISER- M	IISER- P	IISER- TVM
2016	1.14	2.87	4.47	10.72	2.51
2015	1.42	1.52	3.18	3.5	Nil
2014	2.8	2.51	4.76	2.57	0.4
2013	2.95	2.25	1.64	2.93	0.52
2012	0.83	3.03	0.58	Nil	Nil

Result- IISER P (19.72), IISER M (14.63), IISER K (12.18)

TABLE 11: WFC OF INDIVIDUAL IISERS AMONG IISER IN LIFE SCIENCE

WFC/(AC)	IISER- B	IISER- K	IISER- M	IISER- P	IISER- TVM
2016	Nil	0.17	1	0.21	1.37
2015	Nil	0.13	1	2.55	1.55
2014	1.02	Nil	1	Nil	1.03
2013	2.04	0.55	1	0.14	0.15
2012	Nil	0.28	0.17	Nil	Nil

Ranking

Result- IISER M (4.17), IISER TVM (4.1), IISER B (3.06)

Chemistry

TABLE 12: WFC OF INDIVIDUAL IISERS AMONG CHEMISTRY

WFC	IISER- B	IISER- K	IISER- M	IISER- P	IISER- TVM
2016	23.38	4.65	2.81	24.73	9.92
2015	23.11	5.36	5.8	18.96	4.76
2014	17.08	7.38	2.5	14.75	5.6
2013	8	4.27	2	14.97	4.09
2012	4.5	5.08	0.03	3.09	1.78

Result-IISER P (76.5), IISER B (76.07), IISER K (26.74)

Earth and Environmental Science

A relatively low score for the Environmental and Earth Sciences for all 5 IISERs is attributable to the absence of department, lack of Infrastructure for the department and to lower a number of faculty members in the department.

TABLE 13: : WFC OF INDIVIDUAL IISERS AMONG ENVIRONMENTAL SCIENCE

WFC	IISER-B	IISER-K	IISER-M	IISER-P	IISER-TVM
2016	N.A	N.A	1	N.A	N.A
2015	N.A	0.13	N.A	0.38	N.A
2014	0.2	0.2	N.A	N.A	N.A
2013	N.A	N.A	0.03	N.A	N.A
2012	N.A	N.A	0.03	N.A	N.A

Result- IISERM (1.06), IISER P (0.38), IISER K (0.33)

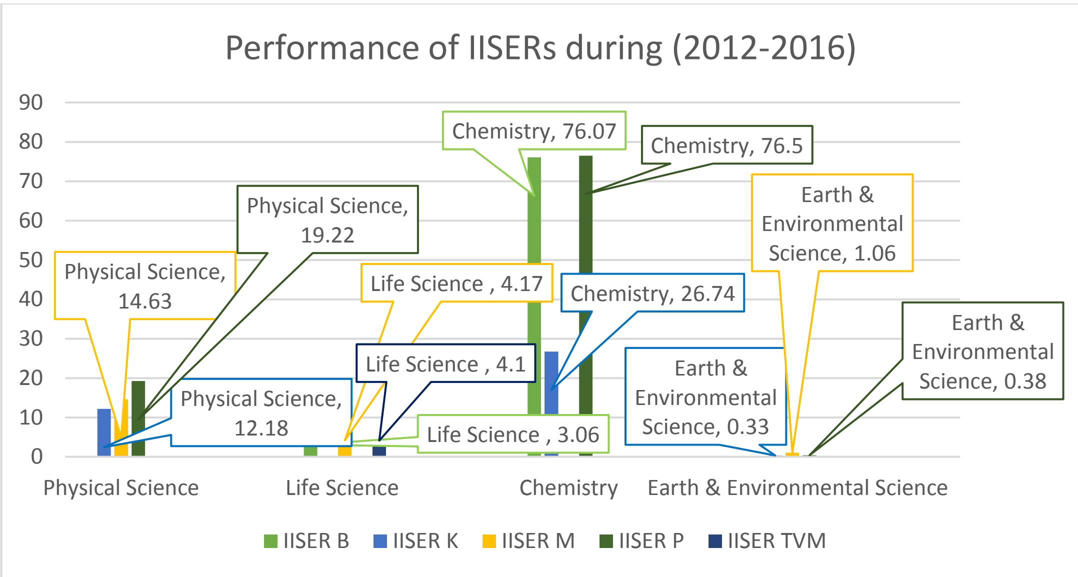

FIGURE 10:PERFORMANCE OF IISERS DURING (2012-2016)

(* The above plot is based on WFC score of combined five years)

IISER Mohali has performed nearly the best in the last five years (2012-2016) in the disciplines of Physical Science, Life Science and Earth & Environmental Science, while IISER Bhopal, IISER Pune have done great in the discipline of Chemistry.

Looking at only the number of publications in Nature, it can be seen that IISER Mohali's Physics and Life Sciences department take the lead while IISER Bhopal outshines in Chemical Sciences. The department of Physical sciences and chemical sciences of IISER

Pune have consistently been competing for the best position in the league of IISERs. IISER thiruvananthapuram has delivered on the Life Sciences publications. What makes IISER Kolkata stand out is the balance amongst the departments. All except its chemical departments have been consistent in the rate of publication.

The above rankings are based solely on the last five years Nature Index data, but there are many other journals where faculties from all IISERS publish their research paper such as Elsevier, Science Direct, Royal Society of Chemistry, Dalton Transactions, Perls, Cell.

It is impressive that the IISERs, less than a decade old are able to stand up to compete with centuries old International Institutes and surpass many domestic and universities. How did IISERs manage to get publications in Nature, so soon after their establishment while the universities usually have none or too few publications even after multiple decades of the establishment?

There is no doubt that IISERs have been regular in getting scientific researches published in Nature.; IISERs(put together as one) ranked fourth from 2012-2015 among the Institutes that appeared in the list of Indian Institutes getting publications through Nature. Recently, IISERs (put together as one) have scored the third rank in 2016 surpassing IISc Bangalore.

The prime reason for this success is the Academic curriculum, Research Infrastructure, Financial expenditure, Autonomy and the Interdisciplinary ideology. It is to be emphasised again that even after the exponential increase in the number of universities in India, the research output was not significant but with the advent of IISERs, NISERs, CBS and others, the research output of the country has increased in number and improved in quality.

Many professors working in prestigious universities and industries joined as faculty members in IISERs for their research careers because IISERs offered higher research potential, by and large than any other options they would have had. Certainly, when we look at the authors of the published papers, it will be seen that although the research guides steered the ship of success for IISERS, the contribution of students of IISERs, even those from the undergraduate level is tremendously higher than the culturally dominant lab scenarios in India.

GENERAL TREND OF THE SCIENTIFIC RESEARCH IN INDIA

According to the Arshia Kaul's[25] work on the Science publication in India from bibliometric indicators, the number of research publications has grown exponentially from 2000-2016, as shown in fig 11. Similarly, Nitin Kumar (in his article in Current Science)[27] has emphasised upon this exponential trend of scientific publications.

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[25] (Kaul, 2014)

[27] (kumar, 2016, p. 1136)

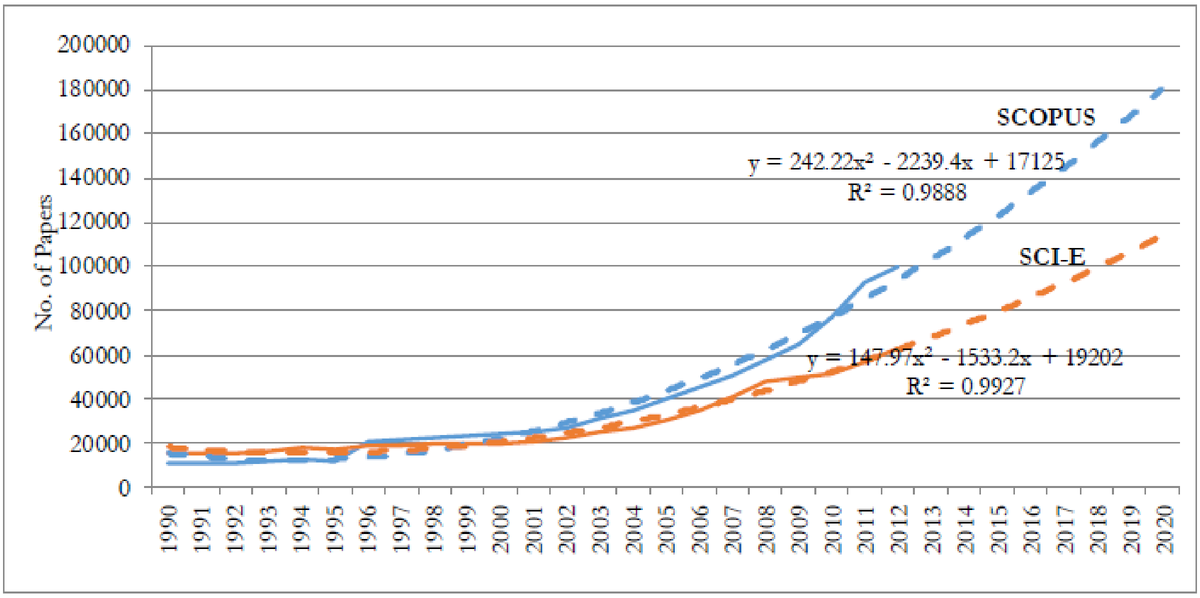

Figure 11: Trend of Indian science publication and forecast Source: (Kaul, 2014)

SUMMARY

In National Institution Ranking Framework, IISER Mohali scored 52th rank, IISER Mohali would have scored a much better rank because IISER Mohali lack industrial collaboration and consultancy research which are two major areas that can significantly improve institute ranking. The research papers in the journal of nature are considered to be of paramount importance because the acceptance rate of this journal is less than 10% and having the very high impact factor of more than 40[28]. Therefore, publishing in this journal brings any institute on the global scientific research map. In 2016 the collective work done by all IISERs was impressive. They surpassed IISc and scored the third Rank, which is a big achievement for IISERs. It is affirming to find that the number of annual publications in Nature from IISERs is linearly increasing. It is impressive that the IISERs, less than a decade old can stand up to

[28] "The publications are characterised by the three parameters, AC- Article count, FC- Fractional, WFC- weighted fractional count.
AC- a count of one is given to an institute or country, if one or more author of the research article is from that institution or country, regardless of how many of co-author are from that institution or country.
FC- It is the fractional count that takes into account, the percentage of authors from the institutes per article. For calculation of the FC, all authors are considered to have contributed equally to all article. The maximum combined FC for any article is 1.0.
WFC- the weighted fractional count (WFC) is the modified version of FC in which fractional counts for an article from specialist astronomy and astrophysics journal have been down-weighted. For more information, visit the link"

compete with centuries-old International Institutes and surpass many domestic and universities (Ibid, Nature Index Analysis, pg.: 45). Many professors working in prestigious universities and industries joined as faculty members in IISERs for their research careers because IISERs offered higher research potential, by and large than any other options they would have had. Certainly, when we look at the authors of the published papers, it will be seen that although the research guides steered the ship of success for IISERS, the contribution of students of IISERs, even those from the undergraduate level is tremendously higher than the culturally dominant lab scenarios in India.

According to the Arshia Kaul's[29] work on the Science publication in India from bibliometric indicators, the number of research publications has grown exponentially from 2000-2016. (General trend of the scientific research in India)

[29] (Kaul, 2014)

CHAPTER 4

SURVEY OF CURRENT STUDENTS AND ALUMNI

(The survey was conducted for the whole population of IISER Mohali community (current students and alumni) on IISER Mohali students' Facebook group, on 19 March 2017.)

Q1: Should the administration collect feedback form for evaluating the teaching assignments of the courses in the middle of the semester? Write an opinion on it.

Discussion: We have been able to gather feedback on this question from 37 students. Feedback forms serve an essential purpose in giving an instructor a way to improve his/her teaching by real feedback from students. In IISER Mohali, students often have the reasons to criticise the feedback system. More often than not, despite the negative feedback on the performance of a faculty member, the same faculty member is seen to offer the same course in the following semester, leaving students doubt the administration's real intent to collect anonymised feedback from them. The Institute authority can address the problem by closely monitoring students' feedback on a particular faculty member for two successive semesters. If it is seen that the faculty member gets the same type of reviews again and again, she/he could be issued a notice to correct her/his method of teaching and evaluation. Also, SRC (Student Representative Council) should be allowed to collect the feedback of a faculty member within a semester from the class representative. If a faculty member failed to teach well, he/she should not be given the same course again. The concerned faculty member's academic CV should not come in the way to dissuade the authority to take corrective measures against her/him. The respondents conclude that it would be better if feedback is collected in the middle of the semester, so that the problems can be addressed amicably during the rest of the semester.

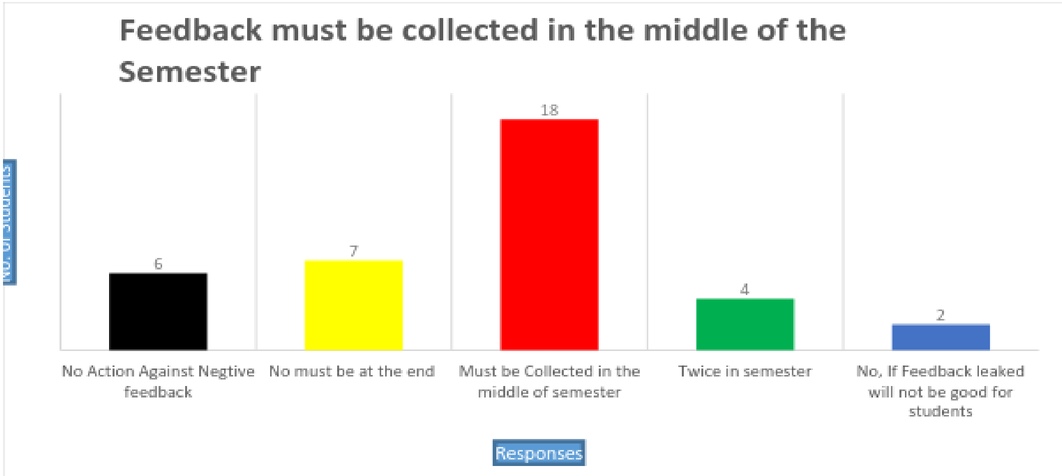

FIGURE 12: FEEDBACK, SURVEY

Q: **Will it be a good idea if the HSS Department begins to offer a Major after the second year of the BS programme?**

Discussion: Currently, students can only choose Chemistry, Biology, Mathematics or Physics as Major subjects, after their successful completion of the first two years of coursework. As many as 37 students have responded to the aforementioned question. They said, often a large number of students get interested in EES and HSS after taking core courses that these two departments offer in the first two years. In addition, about 15 percent of students end up doing their final year research projects with faculty members in these departments. These departments cannot offer Majors due to the paucity of faculty members and infrastructures. However, a possibility of reducing Major mandatory courses and offering co-Majors still exist and should be considered. This will provide students with more flexibilities to pursue their academic and other interests during their long stay at IISER Mohali. Also, this interdisciplinary approach is more likely to improve BS-MS students research involvement. Students responded positively for the formation of HSS as Major. Some students also mentioned that the HSS Department could offer a Major in Science Technology Studies (STS), which would enable students to grapple with the complex relations between science and society. Such a course might be helpful for students to opt for careers in science journalism and science writing. STS also has a considerable appeal in academic market in the US, Japan and in Europe. Some students can also pursue STS in their PhDs abroad. Overall, students were of the opinion that a well-choreographed HSS Major could be well-integrated to the overall pedagogic framework of the Institute.

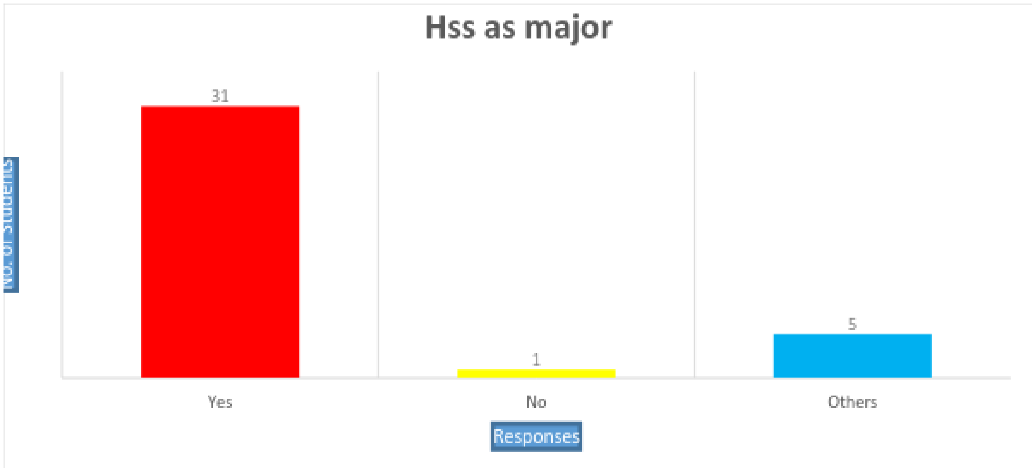

FIGURE 13: HSS AS MAJOR, SURVEY

Out of 37 students, 31 students responded HSS must be a Major.

Q: Should IISERM allow Placement Cell/Opportunity Cell to offer job opportunities for students who do not have the interest in pursuing science after BS-MS?

Discussion: IISERM was built for students to pursue science for doing research in frontier areas of science and contribute meaningfully to the development of the country. The founding figures of the IISER system were naturally averse to the idea of an opportunity cell since, they thought, such a thing would eventually drain out some bright minds to industry. It is significant to note, almost all the 42 student-respondents responded that IISER Mohali must have an active placement cell.

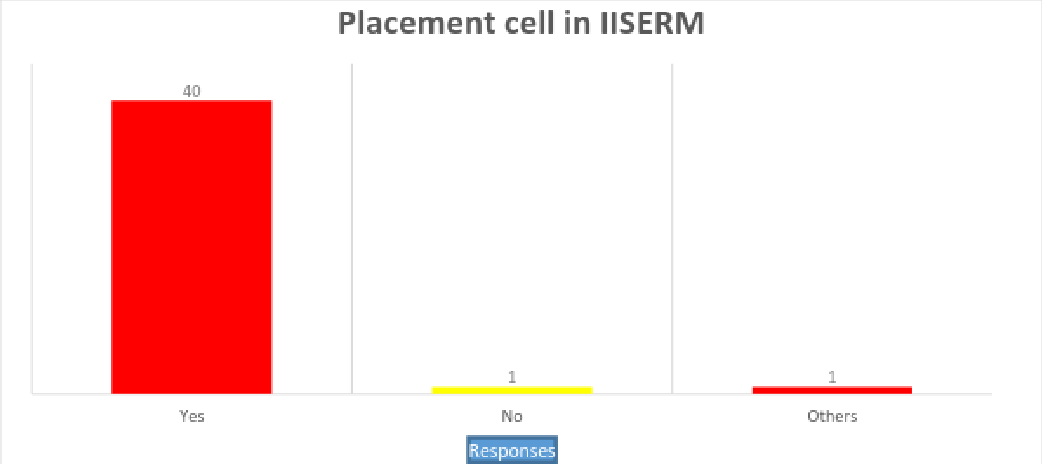

FIGURE 14: PLACEMENT CELL IN IISERM

Others:

The activities in Opportunity Cells strengthen an educational institute's reputation and enable a strong fellow feeling among the alumni. IISERs should not fall short of providing opportunities to all students irrespective of their choice of career. Unfortunately, India is still a developing country and it has limited scope in fundamental research. Hence, it is unrealistic to expect all students to pursue science as a career.

Subjective Questions

Q: **What can be done innovatively to encourage BS-MS students towards science at either Institute level or student level? (assuming that these two-year shapes thinking of a student)**

Discussion: It is often observed that some of the very well meaning and dedicated students begin to lose interest in science subjects in the first two years of their stay at the Institute. A number of our respondents emphasized the need for support of some kind which could enable the students to retain interest in science subjects. Furthermore, to make the large class interactive is itself a daunting task. Therefore, to drive the interest of students IISER Mohali has to organize some creative events.

Only a few students have responded to this question. A thematic analysis is not possible for this data set.

Responses:

- Make the courses engaging and interactive, with less burden.
- Making class more interactive.
- Often, showing how science education affects the daily life helps. I know how the quantum mechanics and the quantum world works, but how does that affect me? How

can I use what I know and what I must know to apply these theories? Examples of such sort with every study would help (I think).

- Make courses more innovative.
- Counselling can help.
- Decrease the course load.
- At the beginning of the course, things like abstract algebra are offered to the first-year students. Each year, several students end up getting an F grade in this subject. However, as students graduate into the third semester, the mathematics course becomes easier. Hence, a balanced reshuffle of the course structure is much needed.

Q**: How can the Institute further promote students' interest in higher learning rather than just relying on student's self-interest of pursuing science?**

Discussion: Institute must also provoke and drive the interest towards science, such as talks, symposia, and more activities like it, so that students get more exposure of science and the way of doing science at IISER Mohali.

Responses:

- Most important change that needs to be doing is restricting the student intake. If IISERM would taking 200 students per batch then apparently the standard of teaching will go down.
- It is not just a problem with IISERM; it has to do with the system in India. The initiative has to be taken by the government. The institute is trying its best to promote higher studies in sciences.
- Recruit better faculty. People who know basics, and their research area.
- Sharing success stories and statistics of alumni to keep the students motivated.

Q: **To the IISRM Alumni: Students that are in science fields and students who are in other fields (M.B.A, Civil services, self-employed etc.) after MS, what Sort of flaws do you see in IISER System and How to overcome it (by experience you have gained in the new universities)?**

Discussion: The alumni are the ones who can evaluate the system better than the current students, due to their exposition to the new professional life. As many as seven alumni, currently working in various fields, responded to this question.

Responses:

- I am a PhD Student. The only shortcoming, I find in **IISER system is not allowing students to choose a thesis advisor from other places** (I think they have changed this policy now, but I am not sure). In all other respects, I believe that IISERs have managed to provide a reasonable level of Master's education.
- If I compare the IISER system with other international universities, I find significant similarities. One suggestion will be to improve teaching methods, in particular for the first two years.
- There is no accountability on the faculty. They have too much power (power to grade) and no responsibility (on the delivery of quality lecture). Students or SRC must have the ability to change a course instructor if the feedback is shallow. In a democracy, the government is for the people, by the people, of the people. Re-election (after every five years) makes the government accountable.

- IISER's success is dependent on the performance of the faculty. Students should be spending their day in the labs rather than sleeping through the day in hostels

SUMMARY

Feedback forms serve an essential purpose in giving an instructor a way to improve his/her teaching by real feedback from students. In IISER Mohali, students often report grievances on the existing feedback system. Students strongly feel that if a faculty member failed to teach well, a new faculty should replace her/him and run the same course again. An overwhelming majority of respondents felt that feedback must be collected in a middle of semester. At present, students can only choose Chemistry, Biology, Math or Physics as a Major. Often students after exploring elective courses in Earth and Environmental science and Humanities and Social Science develop interests in these fields, and some students also do their final year research project with people in these departments. This will provide students with more flexibilities to pursue their academic and other interests during their long stay at IISER Mohali. Out of 37 students,31 students responded that HSS must be a major. Surprisingly, almost all the students responded that IISER Mohali must have a well functioning Placement Cell, since it is evident that one can lose interest in science in the two years of BS despite having a genuine interest. So, there is a need for support of some kind an input that should drive the interest of BS student towards science. Some students responded as 1) Make the courses engaging and interactive, with less burden, 2) Make courses more innovative and allow better research projects. Institute must also provoke and drive the interest towards science, such as talks, symposia, and more activities of such kind. Every organisation private or government needs development, for development one need to find the flaws in the system and then one needs to come up with a solution. Over the past decade, hundreds of BS-MS students and several PhDs have graduated from IISER Mohali. Their feedback is important to develop an understanding of the Institute.

CHAPTER 5

NEED FOR MORE IISERS

IISERs, NISER, and CBS are government institutions established to promote Basic-science in India. As of 2017, there are 23 IITs, 40+ CSIR Labs, and other National laboratories in India that focus on technological research and development. Institutions that promote basic-science are still fewer than their technological counterparts. Moreover, as discussed in chapter-1 and chapter-2, there was a need of IISERs because it was challenging to strengthen existing universities. As emphasised by Zare[33]: IISERs and new Central Universities, both started their journey from the same year yet (as of 2017) IISERs are far ahead of the new central universities and top universities of India in the context of scientific research output.

Statistics of Publication in Nature[34] (IISERs, Universities, and Central universities)

TABLE 14: STATISTICS OF PUBLICATION IN NATURE OF IISERS DURING (2012-2016)

WFC	IISERS					
Years	IISERB	IISERK	IISERM	IISERP	IISERTVM	Total
2012	5.33	8.39	0.74	3.09	1.83	19.38
2013	12.99	6.02	4.67	17.97	4.76	46.41
2014	21.09	10.08	8.26	17.32	7.03	63.78
2015	24.52	7.01	9.48	24.85	6.31	72.17
2016	24.53	7.7	9.28	34.66	13.8	89.97

(IISERB-IISER BHOPAL, IISERK-IISER KOLKATA, IISERM-IISER Mohali, IISERP-IISER Pune, IISER TVM-IISER Trivandrum)

TABLE 15: STATISTICS OF PUBLICATION IN NATURE BY UNIVERSITIES DURING (2012-2016)

WFC	Universities					
Years	B.H.U	D.U	J.N.U	UOC	UOH	Total
2012	13.8	16.66	10.71	13.76	14.57	69.5
2013	10.47	7.71	13.35	8.8	19.1	59.43
2014	11.78	10.87	8.27	10.68	20.04	61.64
2015	6.47	10.38	6.78	10.24	20.82	54.69
2016	5.91	8.13	5.01	10.69	17.18	46.92

B.H.U-Banaras Hindu Universities, D.U-Delhi University, J.N.U-Jawaharlal Nehru university, UOC-University of Calcutta, UOH- University of Hyderabad)

[33] (Zare, 2016)

[34] Data collected from https://www.natureindex.com/

TABLE 16: STATISTICS OF PUBLICATION IN NATURE BY CENTRAL UNIVERSITIES DURING (2012-2016)

WFC	Central Universities									
Years	CUR	CUKE	CUKA	CUJ	CUPB	CUHY	CUHP	CUG	CUTN	Total
2012	N. A	N. A	N. A	N. A	N. A	N. A	N. A	N. A	N. A	0
2013	0.32	0.11	N. A	N. A	N. A	N. A	N. A	N. A	N. A	0.43
2014	N. A	0.13	0.13	1.17	0.17	N. A	N. A	N. A	N. A	1.6
2015	N. A	N. A	N. A	N. A	0.06	N. A	N. A	N. A	N. A	0.06
2016	1.08	N. A	N. A	N. A	0.02	0.1	1	0.29	0.39	2.88

(CUR-Central university of Rajasthan, CUKE- Central University of Kerala, CUKA-Central universities of Karnataka, CUJ- Central universities of Jharkhand, CUPB- Central universities of Punjab, Bathinda, CUHY- Central universities of Haryana, CUHP- Central University of Himachal Pradesh, CUTN- Central universities of Tamil Nadu)

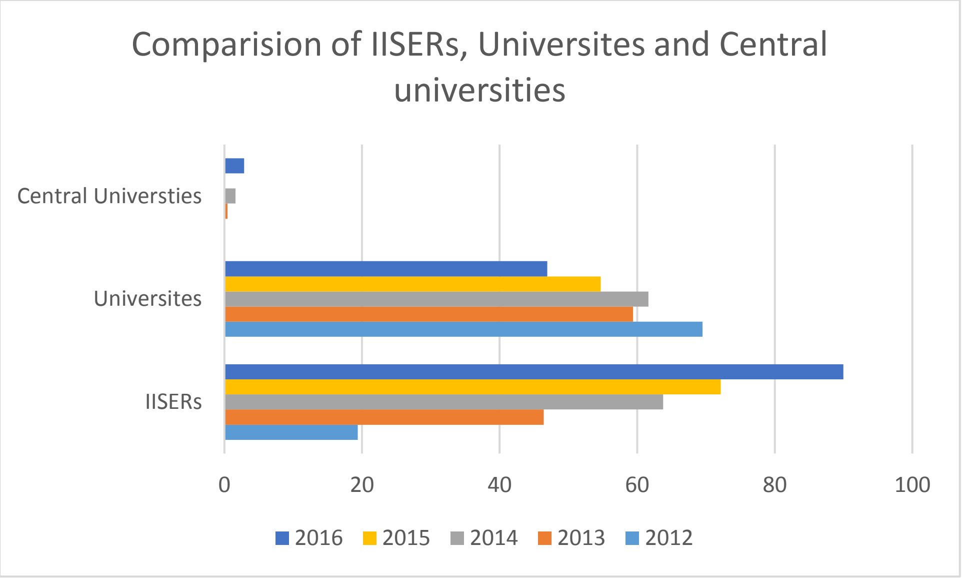

FIGURE 15: COMPARISON OF IISERS, UNIVERSITIES AND CENTRAL UNIVERSITIES

It can be seen from Figure 15 above that IISERs publications have been taking the lead since 2012 amongst the Universities, IISERs and Central Universities. The scientific output of the central universities during 2012-2016 is meagre when compared to IISERs and established Universities. IISERs have been contributing significantly to the research output of our country. But has India achieved the target of becoming a respected nation in the area of fundamental research? What more should be and can be done to improve upon the attempt? One suggestion is that the network of IISERs should be populated more as IISERs have proven themselves clearly beneficial or successful in uplifting the research standards of India and left behind decades old universities and a century old IISc in their research output. Increasing this network will result in both enhancing the research output and creating highly skilled research workforce.

Before preceding further, there's a need to remind ourselves with the difference between basic and applied sciences. Basic sciences deal with scientific theories and phenomena in general. On the other hand, in applied sciences, basic sciences are used to develop new methods and technologies for everyday life. The below illustration will clear the above-stated fact.

Acharyya[35]:

What is common in "UBER app" and "Einstein theory of Relativity"? How can the Uber driver, spot a person on the map and reach their location using satellite service? Satellites that are orbiting around the earth communicate with the local GPS (phone) to indicate your precise location. As long as the precise locations are known, the time it takes to reach the signal to travel at the speed of light gives the distance, and hence, the location of the device.

The disciplines of pure science and applied science are profoundly intertwined and feed each other. Therefore, pure science is equally important as the applied science, if not more. Thus, establishment of more IISERs will be beneficial to humanity within and beyond the national boundary.

As analysed by Arunachalam,[36] from 1993 to 2004, the universities and research institutions were doing scientific research and publishing. However, a comparison with other developing countries, such as South Korea, Brazil and China show that India's scientific output was declining as compared to other countries.

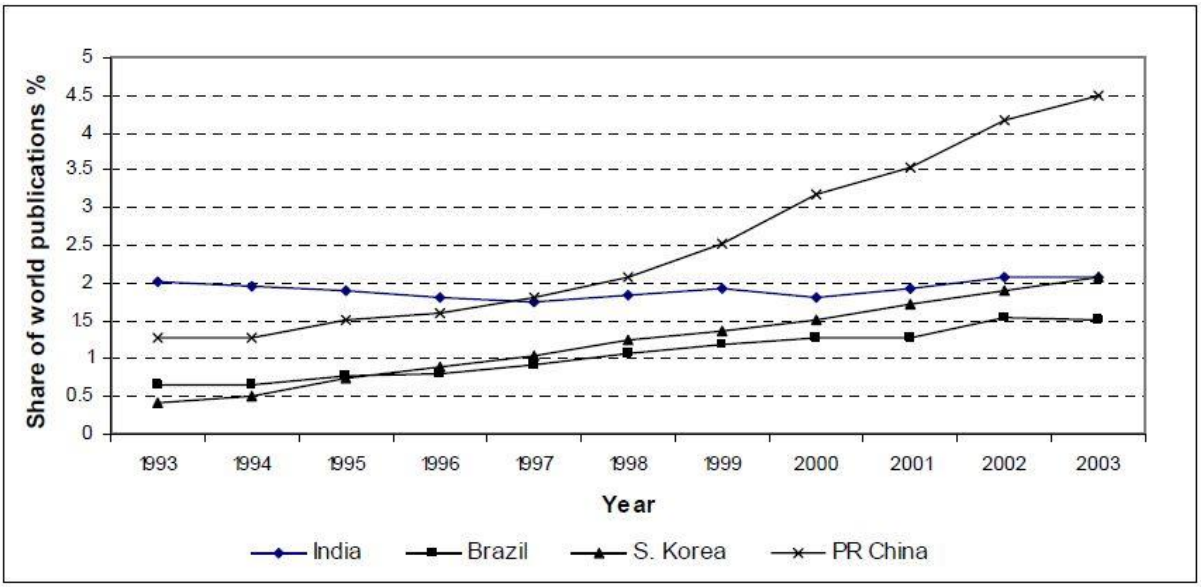

FIGURE 16: INDIA SCIENCE PUBLICATIONS VS OTHER COUNTRIES DURING (1993-2003)

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[35] (Acharyya, 2017)

[36] (Arunachalam, 2004)

The trend of scientific publications from India during 1990-2016 show exponential growth[37]. Thus, it can be said that the number of research publications has significantly increased since new institutions such as IISERs, NISER, CBS, and others have come into existence.

Also, as emphasised by (Singh V. K., 2016) the number of citations received by all IISERs is much higher as compared to rest of India indicating that IISERs contribution to scientific publishing significant.

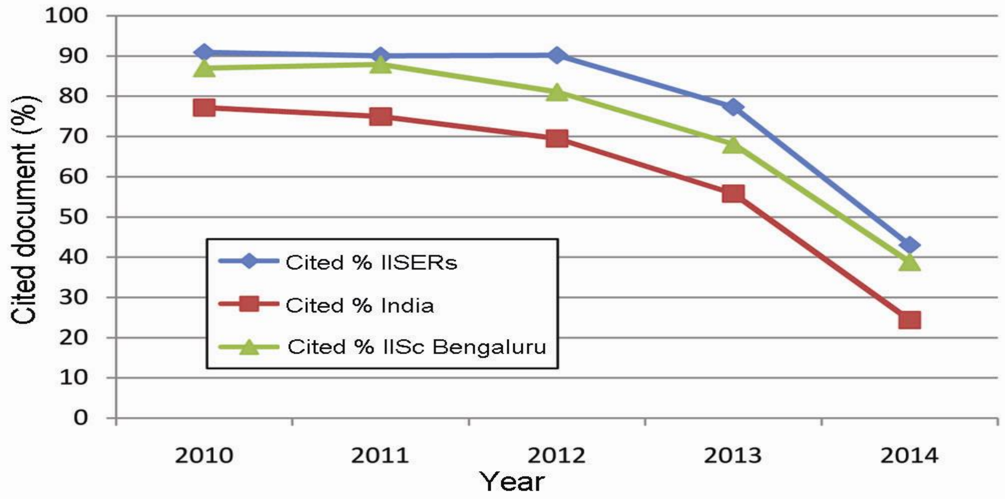

FIGURE 17: CITATION OF IISERS, IISC, AND INDIA DURING (2010-2014) SOURCE: (SINGH V. K., 2016)

Lower Research workforce in India

According to the research in Nature (2015), in Science, India lags behind most of the world in number of researcher's per capita population. This is because of lack of good universities and institutions that produce skilled researchers and in some institutions the pedagogic methods and infrastructure need to be improved. Also, the factor that affect students in higher education is the student/faculty ratio as per U.G.C is 1:12 for post graduate, but as of 2017 it is 1:20 in all institutions (A.I.S.H.E) and much more when compared to developed countries.

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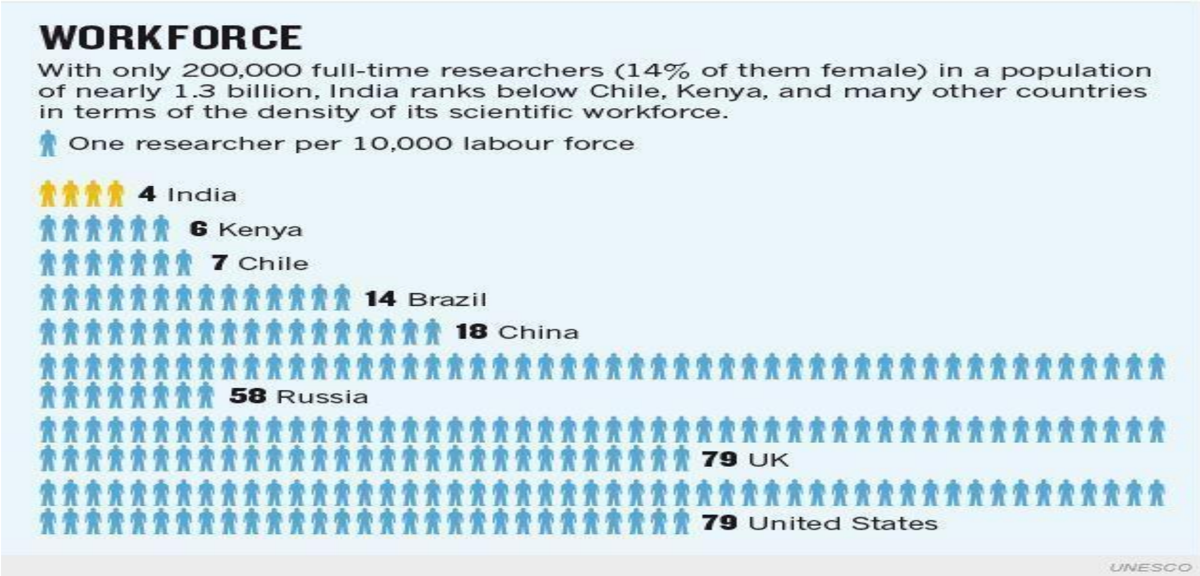

FIGURE 18: RESEARCHER OF INDIA PER 10,000, SOURCE: NATURE (2015), INDIA BY ITS NUMBER

It can be seen that India has only 4 researchers per 10,000 labor force. Even China has 18 researchers, very far less than any other leading countries. The other possible reasons why research is not pursued is the communication gap, less awareness and high student-teacher ratio in primary, secondary, senior secondary education. In this context**,** there is a need of more science-based edifice to create a scientific workforce in India. The number of institutes that create science graduate in India is few and each IISER can only enroll maximum 200 students at the Undergraduate level. So, there is a strict need for more IISERs.

Furthermore, as we have seen in chapter1, that the enrolment in PhD overall is about 0.5% which is about 1,26,451 students that are far very less than required.

SUMMARY

IISERs, NISER, and CBS are government institutions established to promote Basic-science in India. As of 2017, there are 23 IITs, 40+ CSIR Labs, and other National laboratories in India that focus on technological research and development. Institutions that promote basic-science are still fewer than their technological counterparts. IISERs and new Central Universities, both started their journey from the same year yet (as of 2017) IISERs are far ahead of the new central universities and top universities of India in the context of scientific research output. The scientific output of the central universities during 2012-2016 is meagre when compared to IISERs and established Universities. IISERs have been contributing significantly to the research output of our country. The network of IISERs should be populated more as IISERs have proven themselves clearly beneficial or successful in uplifting the research standards of India and left behind decades old universities and a century old IISc in their research output.

The disciplines of pure science and applied science are profoundly intertwined and feed each other. Therefore, pure science is equally important as the applied science, if not more. Thus, establishment of more IISERs will be beneficial to humanity within and beyond the national boundary. India lags behind most of the world in number of researcher's per capita population. This is because of lack of good universities and institutions that produce skilled researchers and in some institutions the pedagogic methods and infrastructure need to be improved. In this context**,** there is a need of more science-based edifice to create a scientific workforce in India.

CONCLUSION

In this dissertation, we have tried to accomplish three major tasks. First, we laid out the terrain of the higher education climate in India after Independence and then we charted out the milieu that prompted a general discourse on more establishment of science education and research in contemporary times. Second, we documented the saga of the installation of the IISER system in different parts of India. Subsequently, we made a case study of the current state of affairs in one of the IISERs (IISER Mohali) to get a sense of the everyday life of the said system. We have tried to show how over the last decade, the system passed through a troubled time and could establish an adorable example in terms of developing human capital in the field of basic science. Needless to say, a success story is more a story of success than of failure. We have tried to document the students' perspective of institutional improvement, and blended the same with the perspective of the founders of the system.

Histories of institutions are not rare (Douglas, 1986). However, in most of the cases, such histories were re-constructed decades after those institutions started their public lives. As a result, in many such cases the richness of oral narratives is compromised. The dissertation, on the contrary, makes an attempt to archive institution building, before the past merges into the myth. In addition, the work helps us understanding the nature of the public (higher) education sector since the liberalization of Indian economy—a task rarely undertaken in the Indian context. The study further enables us to comprehend the current conjuncture, when investment in higher education is transitioning to the private/corporate sector. Overall, the dissertation has attempted a contemporary social history of science institutions in India, and it bears the signature of its time.

APPENDIX A

INTERVIEW WITH EX-DIRECTOR OF IISER MOHALI (N. SATHYAMURTHY)
Director Sir interview (Oral history)

Interviewer: Myself Taranpreet Singh (MS12044)

Interviewee: Formerly Director of IISER Mohali N. Sathyamurthy

(3pm-4pm,5 April 17)

Prof Govind Swarup of N.C.R.A Pune and Prof. V.G Bhide of Pune proposed the opening of an (Advanced centre of science and technology education) in 1996. Which involves five-year MS/MTech program, which integrates teaching and research, collaboration with other universities and collaboration with science agencies. Subsequently, the name got changed to National Institute of Science) and finally in the end in 2006, IISER at Pune emerged. How did it all happen? The reason for opening such an institute to check the declining state of education in pure science and applied research, opening a model institute in Pune and then opening further institutes in other places.

(Director: Dir; Taranpret Singh: TS)

TS: Was there any Politics involved in setting up an IISER in Punjab.

Dir: I would not say there was politics involved in, people in Pune got together and wanted an institute of science within the framework of Pune University. The Government was supportive of the idea, and it agreed to set up an institute of science. Whenever a government or somebody decided to set something up, the Final name was not determined beforehand. At one stage, it was National Institute of science, and then Institute of Science was considered, but regardless of the name, the basic idea was to set up the institute of science which includes undergraduate education in science with research. Whereas traditionally Indian Institute of Science Bangalore, which was the only Indian institute of science in the country involved post-graduate study and research. There was no undergraduate education there at that point; there was an institute of science in Bombay, there were other few Institute of science in the country. However, nothing on the scale that was proposed, and accepted eventually by the government. In the case of Punjab, it seems, Prof S.V. Kessar of Punjab University wrote a letter to Dr. Manmohan Singh, the then Prime Minister of India, saying that there is a need for such an institute in Punjab, Punjab-Chandigarh region… then S.A.C announced the IISER in Punjab in (Mohali).

TS: They initially proposed to set up national institutes of science in

North in Allahabad, South in Chennai, West in Pune, East in Bhubaneshwar,

Is it because of land acquisition for IISER in Punjab appeared easier, or something else was the reason?

Dir: No, NO. One has to look at it carefully. When original Proposal for setting up the institute of science in Pune was agreed in principle by the Government, it also decided to establish in Allahabad, Bhubaneshwar, and Chennai. It was NDA government at that time then when the Government changed, the new Government (UPA 1) considered proposal entirely from the scratch. This time Scientific advisory committee to Prime Minister proposed two places for IISERs Pune and Kolkata. For whatever consideration, it was then up to the Government to take the decision. Then the prime minister of country Dr Manmohan Singh decided to set up the Institute in Punjab quite likely as the follow-up to the letter from Prof. S.V. Kessar. You know, Dr Manmohan Singh knew Prof S.V. Kessar personally, they both knew each other for a long time in Punjab University, and they respect each other.

TS: Does IISER Mohali have in its custody the official letter and documents pertaining to this historic decision?

Dir: We do not have a copy, one could ask for a copy of the same from Prof. S.V kessar if he/she wants.

TS: How did Government Officials in Punjab react to the decision?

Dir: They were very supportive, I was received at Railway station by a Representative of Punjab Government from the Education Department, Dr Jagdeep Singh. He took me to meet the then secretary of higher education and Mr Sidhu (I.A.S Officer), and there was Mr Jaspal Singh (Additional Secretary). Subsequently, he took me to meet (Chief Secretary) R.I Singh (I.A.S officer) he was very supportive and wanted to know what is to be done by Punjab Government…same day afternoon, he held a meeting in (Mahatma Gandhi State Institute of Public Administration (M.G.S.I.P.A) complex with Director general of M.G.S.I.P.A participating in the meeting. The minutes of the meeting said that the Punjab Government would give us 75000 square Feet in a building for a Transit campus.

TS: What sort of challenge did you faced for setting up of IISERM?

Dir: (That is a difficult question to answer) because in the beginning, one does not know, where to begin. The first requirement was space, that was given. Then they said what else do you require? I said, Hostel for the students and housing for the faculty. Then, MHRD talked to Director of NITTTR Chandigarh to give us the Hostel Space. The Punjab Government agreed to allot some space for the faculty housing, which of course, never materialised, but the board of governors decided to reimburse the rental expense for the Director as well as for the faculty. Next was to set up the classrooms and laboratories, because the Government already decided that classes would start by Aug 16, 2007. So, I made the shopping list. I need the telephone connection, I stood there in line and got a phone connection and wanted to get an internet connection, wanted to get website registered, one needs money for any activity. It needs mention, MHRD was ready to send some money. Eventually, the Board of Governors met and the permission was given to open a bank account in Canara Bank Chandigarh, and MHRD gave Money, but In the Meantime, I used my Credit card to make small expenses.

TS: Was there any problems with getting the funds from MHRD?

Dir: In Principle, it is NO, But in Practice, it is a Government Procedure to release the money, the first instalment was two crores. To receive money, I needed a Bank account, To have the Bank account I needed the permission of Board of Governors, for the Board of Governors to meet, to pay the TA/DA, I needed money. So, this was Classic (Catch 22, situation) but MHRD helped by giving a letter asking Canara Bank to open a bank account. Then they deposited money into that account, then the Board of Governors met.

While you stayed in Punjab Bhavan as a state guest for nearly three months as you quoted (life in a cell; but big moral support from the Chief Secretary of Punjab government) (N.Sathyamurthy, Institution Building, 2016)

TS: Was it during this time that the idea of the IISERM started taking shape towards reality? Do you want to share something more about your experience there?

Dir: I will not say the idea… because you know…the notion was already conceived; the basic concept was proposed by the Scientific Advisory Committee to the Prime Minister. The curriculum developed in October 2005, in a workshop held in National Chemical Laboratory Pune. Then the plan was submitted to the Planning Commission, and it was approved by the cabinet, this was the procedure. What was done in three months you are referring to, was to order office furniture, laboratory furniture, classroom furniture and all various things that are needed to set up the office and to start classes on Aug 16, 2007.

TS: Did the IITK permit you to spend Institute in project mode if needed Or You find it a safer option to have a backup plan? (N.Sathyamurthy, Institution building, 2016)

Dir: No, Before I came to Mohali when I met with the director of IITK, he offered that I take an amount of INR 5 lakhs in the project mode, to take care of the initial expenses, but I did not have to do that. I just took care of it with my credit card…and then quickly the money along with the reimbursement came from MHRD.

TS: I assume, Prof. C.N.R. Rao also helped you for setting up of the Institute?

Dir: Main thing is IISER formula already worked out for Kolkata and Pune, I only followed that formula, and for Kolkata, he was the chairman board of governors to speak to them he was advising them to go about and set it up. Our own First Board of Governor P Rama Rao who was of great support. But, the driving force was Prof. C.N.R. Rao in giving the template, how to set up an institute.

M.G.S.I.P.A complex in which Transit campus start in sec 26, Chandigarh

TS: Which of the government officials and faculty members of universities/institutes had helped you to start the Institute and to run the classes?

Dir: Dr Jagdeep Singh came as the representative of Punjab Government on Day 1, but, Director IIT Kanpur had asked me to request the Punjab Government to depute somebody to help me setting up the Institute, because government official from local authorities would know, how to get things done, whom to contact, how to go about and to get things done, and so on. Dr Jagdeep Singh was the Deputy Director of the Punjab Government in the Education Department. He was agreed to be deputed, and Chief Secretary also deputed him. It turned out that he had experience of teaching Biology and had some Administrative experience with the title of Coordinator. He coordinated the efforts of setting up of IISERM and he had helped to teach Biology Course at the beginning. From Punjab University, Prof Ramesh Kapoor agreed to teach Chemistry. Prof. C.G Mahajan decided to teach Physics, Prof. I.B. Passi decided to teach Mathematics. All of them decided to help me.

TS: When did the faculty actually start teaching?

Dir: During the period before Aug, 16 2007, somebody suggested to me that Dr Arvind from IIT Madras might be interested in moving to help me to set up IISERM. When I contacted Dr Arvind, he agreed and suggested that Dr Kavita Dorai could also be persuaded to join the fledging Institute. So, I requested Director of IIT Madras to allow these two faculty members to join as visiting faculty on leave from IIT Madras. They were invited as visiting faculty in IISER Mohali. Then, slowly, once the Board of Governors was formed, the advertisement was out, and the recruitment process took place in about a few months' time, Arvind and Kavita Dorai were appointed as the first faculties members.

TS: From which year did the Institute start taking admission(s) of PhD(s) and Postdoc(s): whether in transit campus or after moving to the permanent campus?

Dir: Still in transit campus, in 2008, because it was evident that unless you have research activities going on it is impeccable for the institute to take off. Research activities done by PhD students are essential for faculty to set up their labs and initiate their research.

Now Moving to Permanent campus

TS: What are the problems of doing Science in India?

Dir: The problem of doing science in India is like doing anything in India. Because there is a procedure involved in a government setup and the financial and administrative procedure are not aimed to set up an academic or a research Institution. There are general government rules; one has to find ways and means of working within those rules.

TS: In terms of publications, how has IISERM performed since its establishment?

Dir: I would say, "*We have done reasonably well because it takes a few years to set up labs, to settle down and to start doing meaningful research. Since research in an academic institution like IISER Mohali is done primarily by the Ph.D Students, it takes two to three years before you start producing results.*

TS: Does IISERM need more advanced infrastructure or has it been doing great till now?

(Computer Infrastructure, Hostel Infrastructure, Research Infrastructure, Academic Infrastructure- to be concerned in the answer)

Dir: Every institute is destined to be great forever if it is guaranteed a constant input of excellent students, faculty members and supporting infrastructure. Excellent students are assured because every year there is a new and purely competitive admission process. Fortunately, the best of the minds happens to be in IISERs. The requisite faculty at the moment of conception was lesser in number, but as the institute grows it benefits unexceptionally from the surprising and unintended contributions of its faculty pool. It is a good exercise to have a younger faculty pool, on the average.

TS: What type of role should a science-institute should play in a society in addition to the outreach activities that it is doing? Or is that part left for the applied researchers only?

Dir: No. You see, there is nothing like an applied researcher when you research in science. There is a fundamental question that you try to answer for the benefit of the human society. In IISER Mohali, for instance, Dr Santanu Pal has developed sensors based on liquid crystals, Dr Vinayak Sinha keeps monitoring the pollution- specifically the pollution load arising out of the burning of rice stocks and wheat stocks. Some of the colleagues from the Physics department colleagues have made a fundamental discovery in superconductivity. All of these researches will over the course of time benefit humanity, not only nationally but globally.

TS: Do we need Engineering? Does it open more interdisciplinary research Opportunities?

Dir: You cannot live without engineering science. Science and Technology: they feed on each other. As you progress in science, new technologies are developed. New techniques help us move ahead in science. So, science and technology interact via a feedback mechanism. If you look at the history of science and development, you shall find several instances that tend to unite basic sciences with the applied sciences as against to separating the two. In the specific case of IISER-M, this ideology is retrievable from its mandate. At IISER-M, we must do sciences that are at the forefront in their respective fields. This automatically involves a multidisciplinary approach. If one needs to solve the problem in physics, you need to understand Vacuum technologies, Laser technologies, Superconductivity, Advanced Electronics etc. If you want to study chemistry, you will most certainly need state of the art equipment.

TS: What broad categorisation of strategies should be adopted, so that innovative research could come out of this institute?

Dir: Continue to select best students, continue to select excellent faculty. Give them adequate support, give the academic freedom to pursue what they want and then, excellence would follow automatically.

TS: Would you like to comment on the role played by the RTI, CVC, and Audit. Do they create problems in the researches?

Dir: This is an interesting question. The job of the director is that of a facilitator. Therefore, he sees what can be done to facilitate setting up of the institute, setting up of labs, and carrying out research by the students and faculty. Audit and Vigilance are like the watch-dogs of government to keep watch on you whether you are doing things carefully or not.
This is also desirable because it is the taxpayer's money that we are using. Therefore, we are answerable to the government which in turn is answerable to the taxpayer. Now RTI, it depicts the direct concern of the taxpayer because he has been given the right to information.

TS: Is buying sophisticated instruments an easy task or does it take many efforts?

Dir: See, fortunately or unfortunately, the Government has set up a defined procedure for spending. This method is applicable for buying equipment too. You need to have somebody who is going to use the material; you need to have a committee which decides what that equipment should be and that helps in selecting the equipment and making sure that you get the best equipment at minimal cost. You are forced to ask for tender and look for the lowest bidder, but you have to make sure that lowest bid takes care of your scientific need. If you are not careful, you can buy equipment at the lowest price and will be of no use; This is where one has had to use its intelligence and common sense and make use of the existing mechanism to ensure that you get the best equipment at the minimal cost.

TS: What are the ways for the IISERM to reach Global Ranking?

Dir: If you keep doing good work and publish, file a patent, and if your students do well then slowly you will see your global ranking will improve and there is no shortcut to success.

TS: IISERB is going to start an engineering science as minor from Aug 2017. Is it possible in IISERM?

Dir: This is functional autonomy. Here, there is no financial autonomy. If IISERB has decided to have a department of engineering science nothing prevents IISERM having the Department of Engineering Sciences. In the original mandate, it was not listed, but areas like computer science are included, Material science Robotics. So, it is our judgment as an Institute to decide whether we should have a department of engineering science or not. We are on the lookout for people in Computer Science, Applied-mathematics and a particular area of Humanities and Social-sciences. However, we have not been able to get good people in these specialisations of the disciplines mentioned.

TS: I surveyed with students, and some of their answers intrigue me to put it here, Sir. Most of the industries relied on social as well as Industrial internships. IISERM's approach of the summer projects is too monotonous. What, in your opinion, should be allowed?

Dir: The students have a reason to say that the IISERM-approach of summer project is monotonous or even "Dull". In the first year, we give them some project to help them get started, this is like if you want to become a mechanic, you go to a mechanic and declare to him that: "I want to learn from you". The mechanic says: "Go clean up the car." He asks you to change the oil and service the engine. He orders you to check the pressure in the tires. Naturally, these are tedious processes. Somebody wants to be a mechanic wants to know how the engine works and how it malfunctions. An apprentice thinks that doing a calculation and doing an experiment is monotonous, but this is a necessary precondition in a scientific training by the time they come to third and fourth year before some of them go to opt for a summer project elsewhere. They learn something and come back. Now, if we have a sponsored project from an industry, let's say from pharmaceuticals or electronics, then naturally the students will be able to participate but what the students never realise is that if they are given a role in such a project of this kind, then they will not know the full story behind the project. He/she will only know a part of the experiment that he/she is doing because the company which is sponsoring the project would not like the lead scientist to disclose any of the details (however irrelevant) to any of his/her assistants. So, it is looking rosy to say I am working on a problem relevant to the industry. If you go and work in an industry during summers as an intern, you will find yourself doing the same thing without being informed why you have been asked to make a compound or develop a program.

NATURE ANALYSIS TABLE

Overall ranking of IISERs

2017 (1 Jan 2016 – 31 Dec 2016)[38]

Rank	IISERs	WFC 2016	AC
14	IISER Bhopal	24.53	49
33	IISER Kolkata	7.7	40
28	IISER Mohali	9.28	23
8	IISER Pune	34.66	109
21	IISER TVM	13.8	23

Rankings are in the following order

IISER Pune (8), IISER Bhopal (14), IISER TVM (21), IISER Mohali (28), IISER Kolkata (33)

2016 (1 Jan 2015 – 31 Dec 2015)[39]

Rank	IISERs	WFC 2015	AC
12	IISER Bhopal	24.52	57
35	IISER Kolkata	7.01	40
28	IISER Mohali	9.48	21
11	IISER Pune	24.85	47
42	IISER TVM	6.31	9

Rankings are in the following order

IISER Pune (11), IISER Bhopal (12), IISER Mohali (28), IISER TVM (42), IISER Kolkata (35)

[38] https://www.natureindex.com/annual-tables/2017/institution/all/all/countries-India

[39] https://www.natureindex.com/annual-tables/2016/institution/all/all/countries-India

2015 (1 Jan 2014 – 31 Dec 2014)[40]

Rank	IISERs	WFC 2014	AC
13	IISER Bhopal	21.09	26
28	IISER Kolkata	10.08	19
33	IISER Mohali	8.26	12
17	IISER Pune	17.32	25
38	IISER TVM	7.03	11

Rankings are in the following order

IISER Bhopal (13), IISER Pune (17), IISER Mohali (33), IISER Kolkata (28), IISER TVM (38)

2014 (1 Jan 2013 – 31 Dec 2013)[41]

Rank	IISERs	WFC 2013	AC
22	IISER Bhopal	12.99	17
38	IISER Kolkata	6.02	17
45	IISER Mohali	4.67	10
14	IISER Pune	17.97	28
43	IISER TVM	4.76	13

Rankings are in the following order

IISER Pune (14), IISER Bhopal (22), IISER Kolkata (38), IISER TVM (43), IISER Mohali (45)

2013 (1 Jan 2012 – 31 Dec 2012)[42]

Rank	IISERs	WFC 2012	AC
36	IISER Bhopal	5.33	7
26	IISER Kolkata	8.39	14
106	IISER Mohali	0.74	6
50	IISER Pune	3.09	4
69	IISER TVM	1.83	3

Rankings are in the following order

IISER Kolkata (26), IISER Bhopal (36), IISER Pune (50), IISER TVM (69), IISER Mohali (106)

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[40] https://www.natureindex.com/annual-tables/2015/institution/all/all/countries-India
[41] https://www.natureindex.com/annual-tables/2014/institution/all/all/countries-India
[42] https://www.natureindex.com/annual-tables/2013/institution/all/all/countries-India

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