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Students' perspectives on quality of engineering education in India

Jandhyala B. G. Tilak[A]

A *ICSSR National Fellow and Distinguished Professor, Council for Social Development, New Delhi, India*

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Abstract

It is widely held that engineering education in India has expanded massively at the cost of quality, quality being perceived in terms of, *inter alia*, ranking of institutions in the national and global university ranking systems, and employability and attributes of graduates. Evidence on these aspects is based on the perspectives of the policy makers, administrators in higher education and employers in the labour market. Rarely the students' perspectives on quality of their education are considered in formulating these conclusions. Assuming that students' perceptions on the quality of education, which may differ from prevailing perceptions of the others, are important and they need to be paid attention to in research and policy making, the attempt in this study is to examine this aspect and fill the gap in research to some extent. Based on a survey of about 7,000 students enrolled in undergraduate engineering studies in 48 public and private institutions in four major states in India, this article presents a contrasting perspective on quality of engineering education in India. The findings are indeed perplexing, as a majority of students are 'satisfied' with the quality of education in their institutions, and they are well prepared for the world of work in India or abroad, and/or for further education. These findings will compel the researchers to widen their approach to study quality-related problems of higher education in India, and administrators and policy makers to rethink on their perspectives and associated actions.*

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1. The problem

Engineering education has expanded in India at a high rate of growth during the post-independence period. In 1950-51, when development planning was launched after independence in 1947, India had a meagre 53 engineering degree level institutions. In 2018-19, this number is about 59 times higher, 3,124, with an enrollment of 4.1 million students at first degree level. In 1960-61, there were hardly 37,000 students[1]. The 3,124 institutions include, apart from public institutions, private universities and colleges which account for 87 per cent of the total. The growth in enrollments has probably been faster than anywhere else in the world, and India is now regarded as having the second largest number of engineering students in the world, producing about 0.9 million graduates a year (2017-18). Around 25 per cent of the world's engineers are produced in India (Madheswari & Mageswari, 2020); and India is regarded as the world's number one country in producing engineering and science graduates (National Science Foundation, 2018).

However, it is widely felt that this massive expansion was propelled by democratic and populist pressures, and it has taken place at the cost of quality of education. Except for a small number of graduates produced by a few institutions like the Indian Institutes of Technology (IITs) and National Institutes of Technology (NITs), a vast majority of graduates are regarded 'unemployable' in any appropriate occupation (Aspiring Minds, 2019); in the global university ranking systems, very few institutions figure with high ranks, except a few IITs which also figure after top 100 or 200; in the national system of ranking (National Institute of Ranking Framework), a little less than two per cent of the institutions have been found to have scored above 50 per cent marks; less than five per cent of the engineering graduates are found to have been qualified in the graduate attitude test in engineering (GATE); hardly five per cent of the colleges received 'full accreditation' by the national accreditation body, the National Board of Accreditation (NBA) (VIF, 2019); and even the pass rates in undergraduate studies are very low (Mani & Arun, 2012). Thus, there are strong and well-articulated views on the poor quality of engineering education in the country. The widely prevalent views on the quality of education are also based on robust empirical evidence, but mostly based on the information collected from the educational institutions, employers and other stakeholders – suppliers or producers and users of engineering graduates. Experts and several committees (for example, AICTE, 2003, 2018; MHRD, 2011; Government of India, 2020; Anandkrishnan, 2014; Banerjee & Muley, 2009; Biswas et al., 2011; Loyalka et al., 2016; World Bank 2013; Government of India, 2019) who examined the status of engineering education in India have also commented extensively in this context on institutional expansion, poor infrastructure, less provision of postgraduate and research programmes, commercialisation, ineffective regulation, lack of governance, state control and absence of autonomy, lack of qualified teachers, inadequate public funding, policy vacuum, outdated curriculum, old-fashioned teaching methods, irrelevant skills and knowledge provided by the engineering colleges and universities, weak linkages between universities and industry, and so on. They also made valuable recommendations on these aspects. Many recommended improvement in infrastructure, recruitment of quality faculty, institutional and faculty autonomy, increased public funding, raise in student fees, faculty training and development, restructuring of regulatory institutions, efficient planning and effective regulation of the growth in universities and colleges, focus on research and post graduate programmes, restructuring of curriculum including increase in market relevance of curriculum and introduction of values and ethics, and so on.

Some of the studies are based on surveys of institutions; and so are many of the reports of the expert committees; but not necessarily based on students' perceptions. There are a few studies in India which are also dated that are based on student surveys; but these surveys covered several aspects relating to their socio-economic background, expenditures on education, and employment/unemployment (Rao, 1961; Bose et al., 1983; Senthilkumar & Arulraj, 2011) but rarely focused on quality related aspects and how students perceived the quality of their education. Using students' surveys, Uplaonkar (1983) analysed occupational preferences by gender and Singh (1993) examined costs of higher education in University of Delhi. Vijay (2013) analysed student ratings of quality of higher education using a sigma model approach in India. Using a part of the data used here (on Delhi), Choudhury (2012, 2019) analysed students' assessment of quality of engineering education in India.

This paper examines student perspectives on quality of engineering education in India, a study area that has been rarely examined in the scholarship of learning and teaching literature. Assuming that students' perceptions on the quality of education, which may differ from prevailing perceptions of the others, are important, and that they need to be paid attention in research and policy making, in this paper, an attempt is made to contrast these macro level perspectives of the stakeholders – the employers, the economic and educational planners and policy makers, higher education bodies and other wings of the government, and the society at large, with micro level evidence, essentially the students' perspectives. Rarely students' experiences and views on the quality of education were analysed, though they are the main stakeholders. In this sense, this study contributes to a new dimension of examining quality related aspects of engineering education, as it largely depends upon students' perspectives on about a dozen aspects of quality, and supplements the existing knowledge on the quality of engineering education in India. The paper also highlights the differences between public and private institutions and also between 'traditional' and 'modern' branches of engineering (as explained later). The latter is a new facet that is added here, which has been rarely studied. Merely the results of the survey are reported here, and the paper does not claim any advances in theoretical knowledge or any contribution to methodology, but the empirical evidence is indeed rich and unique. No advanced statistical tools are used. The mere descriptive empirical evidence provided should be of interest to many scholars, administrators and policy makers for their better reflection on the quality and related aspects of engineering education in India. In the current scenario of engineering education in India (see Tilak & Choudhury

1 These figures exclude polytechnics which are diploma (below degree) level institutions in engineering, and students in postgraduate studies (Masters' level studies and research programmes).

2021), the problem identified and the analysis attempted here assume special significance.

2. Database

For this purpose, we use primary data collected through a purposive random survey of about 7,000 students in 48 institutions of engineering education in four major states, namely (National Capital Region of) Delhi[2], Karnataka, Maharashtra, and Tamil Nadu in India. These four states witnessed rapid growth of engineering education in the country. In fact, Karnataka, Maharashtra and Tamil Nadu were the states which took the initial lead in setting up large numbers of institutions. Engineering education expanded very fast in southern and western parts of India, followed by a couple of states in north India. The presence of engineering education is rather minimal in central and eastern India. Karnataka and Tamil Nadu in the south, Delhi in the north and Maharashtra in the west thus represent the three major regions in the country where engineering education grew fast. A structured questionnaire was administered on all the students in the final semester/year of under graduate degree level studies in selected departments – mechanical, civil/electrical, electronics, computer science, and information & technology (IT) related departments were surveyed. While mechanical, civil and electrical engineering are traditionally highly popular branches of engineering, in recent years, electronics engineering, computer science engineering and IT engineering have become more popular.

We term these two groups respectively as 'traditional' and 'modern' branches/streams of engineering here, as we analyse the differences between these two broad categories. Information on students' views on four important aspects, viz., teaching methods used in the classroom, evaluation pattern, skills acquired by students during the course and the involvement of students in different activities, are collected through a questionnaire administered on and interviews conducted with the students. The institutions surveyed include Indian Institutes of Technology (IITs), National Institutes of Technology (NITs) – earlier known as Regional Engineering Colleges (RECs), state universities and colleges, and private universities and private colleges. IITs and NITs are funded by the union (central) government, state universities and state colleges by state (provincial) governments, and private universities and colleges are mostly funded through student tuition and other non-state sources. Private institutions of course enjoy access to research and special funds provided by the state under different heads and the students in private institutions can access state-subsidised loans and fee-reimbursement by the state. Thus the sample includes public, state-aided private and private (self-financing, also known unaided) institutions. We refer to unaided/self-financing institutions here simply as 'private.' State-aided private institutions are very few in India, and the other type of private institutions account for about 85-90 per cent of the engineering education in the country, both in terms of institutions and enrolments. Our sample also represents these relative sizes of the variety of institutions.

Since government-aided private institutions are very few in number, and being funded by the state they follow almost all rules, regulations, practices applicable to government institutions, we combine 'public' and state-aided private into one category as public, unless otherwise mentioned, as against private institutions. Comparison of public and private institutions also forms a focus of the study. Most of the colleges offer only under graduate study programmes, while universities, IITs and NITs enroll students for master's level engineering programmes and research programmes as well, in addition to undergraduate studies. But we considered only the students in the final year of first (Bachelor's) degree studies in all the selected institutions. These various types of institutions might have adopted different kinds of procedures and criteria for admitting students in their institutions. Some students might have taken national level common entrance test, some state level examination, and some institution-level examination. Students include those who secured admission on merit, some on merit cum reservation (quota)[3], some in private institutions under 'management quota' and some under other criteria. Their educational and socioeconomic profiles are varied[4]. Thus, the sample represents the diversity of the institutions and the students in terms of geographical coverage, variety of institutions, and other features, prevalent in Indian higher education, though the numbers of sampled institutions and the students are small compared to the large network of institutions and vast student population. The survey was conducted in the context of a wider international study covering BRIC countries (Brazil, Russian Federation, India and China: Carnoy et al., 2003), of which the author is a part. The sample selection of states, institutions and departments and the design were based on the considerations of the larger study.

The questionnaire used for the students' survey includes a variety of questions on students' perceptions and experiences in the colleges and universities. They relate to their views on the quality the institution the student was enrolled in, the quality of education she/he was receiving, the level of skills and knowledge acquired during the studies, the level of confidence or preparedness for future, the students' participation in various academic and related activities, number and type of major and non-major subjects chosen as a part of their study, etc. We also obtained information through them on the pedagogic methods and the methods of evaluation adopted in the respective institutions. Finally information is also collected on how the students use their time. The descriptive analysis attempted here is based on such information collected by the author from the students' survey and interviews with them, supplemented with the information collected through a questionnaire and interviews of heads/deans of departments/institutions on general, academic, faculty, financial and governance aspects of the institutions and from information collected from a small number of major employers of graduates. So there

2 The sample survey data on Delhi was used by Choudhury (2012) for his PhD dissertation. Based on the same, a few aspects similar to ones we analyse here relating to quality are also analysed (Choudhury, 2019).

3 Constitutionally guaranteed reservations in admission are provided to socially backward sections of the society.

4 See Tilak (2020a, 2020b) for a socioeconomic and educational profiles of the students surveyed.

are some direct and indirect measures that are used here to understand quality and related aspects of engineering education in India. The attempt has been to cover comprehensively the quality aspects of education.

3. Analysis of survey results

i) How do students feel about the quality of their engineering education?

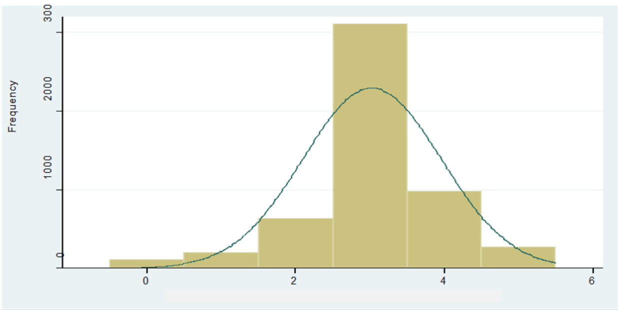
First, we analyse students' perceptions on the quality of education. Reports of many expert committees and media reports often complained about the poor quality of education that is imparted to the students in engineering institutions, particularly in private institutions, which actually dominate the whole engineering education scene in the country. They commented on the poor quality attributes of the engineering graduates and their lack of knowledge, skills and proper attitudes. How do the students feel about it? Do they know that they are receiving substandard education that does not provide any knowledge and skills relevant for employment or for the society at large? One of the most interesting results of our student survey is that students are largely satisfied with the quality of their engineering. Evidence can be cited on quite a few aspects relating to this issue.

a) Improvement in knowledge, skills and abilities

First, students were asked how they felt about their technical knowhow at the time of survey/interviews compared to the time of admission, i.e., after three to three and half years of studies. Most students responded that they felt 'stronger' or 'much stronger' (Figure 1). The knowledge related aspects include essentially knowledge of technology, knowledge of new technology, and knowledge of engineering practices. The details are discussed in the following pages.

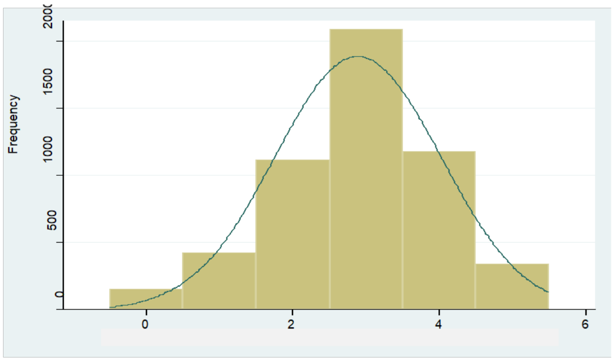
Similarly, when asked about their current level of abilities and skills compared to when they entered the institution, they also felt stronger or much stronger, on average (Figure 2). The abilities and skills on which enquiry was made include ability for collaborative work, problem-solving skills, writing skills, communication skills, academic skills, leadership abilities, intercultural understanding, and knowledge of global affairs.

It will be interesting to look into the details on some of these aspects. Fourteen attributes relating to knowledge, skills and abilities have been identified for assessment. They are: Knowledge of technology, knowledge of new technology, knowledge of engineering practices, knowledge about global markets/economies, ability to communicate in any foreign language, leadership ability, problem-solving ability, academic ability, ability and skills for collaboration for work, writing skills, oral communication skills, intercultural skills, entrepreneurial skills, and ability to appreciate the importance of lifelong learning. As expected, the response of the students varies across these several attributes, as one can note from Figure 3.



0 = much weaker; 1 = weaker; 2 = same; 3 = stronger; 4 = much stronger; 5 = don't know.
Source: based on author's survey.

Figure 1. Students' opinion of current subject knowledge compared to when they entered the Institution (distribution of frequency)



0 = much weaker; 1 = weaker; 2 = same; 3 = stronger; 4 = much stronger; 5 = don't know.
Source: based on author's survey.

Figure 2. Students' opinion on confidence in academic abilities, compared to when they entered the institution (distribution of frequency)

The students responded differently to different questions. They reported that they acquired and advanced considerably their knowledge, skills, and abilities with respect to many aspects. 75 per cent of the students felt that they advanced their knowledge of technology and knowledge of engineering practices. More than 50 per cent of the graduates have reported that their knowledge and abilities are 'stronger' and even 'much stronger' than when they entered the engineering colleges/universities. Among the abilities and skills in other areas, only in case of communication in any foreign language, the improvement has been poor: about 75 per cent of the students did not feel to have improved after starting their studies in engineering education. The areas in which they felt about the same as when they entered were in foreign language skills and entrepreneurial skills. For others, the change is marginal, or towards worsening of the levels of abilities, as given in Table 1. In cases of the others, it is only a small proportion of students, who reported 'weaker' or 'much weaker' or 'the same' than what they were at the time of admission in the institutions.

Table 1 gives these details of responses of students separately by public and private institutions and by streams of engineering – modern and traditional. With respect to almost every aspect students of public institutions score

Source: based on author's survey of students.

Figure 3. Percentage of students reporting that their current knowledge and abilities are 'stronger (+ much stronger') than at the time of admission in the institution

higher than students in private institutions. Similarly students in 'modern' streams of engineering feel stronger (+ very stronger) than students of traditional streams. This is true with respect to knowledge, skills, and abilities in different aspects. Table A1 in the Appendix give further details in responses, such as how many felt 'average' or 'worsened'.

Table 1. Current knowledge & abilities, compared to the time of admission in engineering studies (% of students who reported 'stronger + much stronger')

	Institutions		Branches		All
	Public	Private	Traditional	Modern	
Knowledge of Technology	76.7	72.8	70.9	75.6	74.1
Knowledge of Engineering practices	74.7	70.3	68.2	73.4	71.8
Knowledge of new technology	60.1	54.7	52.4	58.4	56.5
Leadership ability	65.4	61.3	58.3	64.7	62.7
Writing skills	65.0	63.0	62.3	64.3	63.7
Academic ability	59.1	56.6	56.2	58.0	57.5
Oral communication skills	64.3	56.5	55.0	60.9	59.1
Problem solving ability	66.4	62.5	60.0	65.5	63.8
Collaborative ability	72.0	69.3	66.2	72.0	70.2
Interest in lifelong learning	65.2	61.5	60.0	63.9	62.7
Intercultural skills	59.0	55.8	54.2	58.1	56.9
Entrepreneurial skills	55.7	51.6	49.3	54.6	53.0
Knowledge about global markets/economies	53.3	48.1	47.3	51.0	49.8
Foreign language ability	25.9	22.4	24.5	23.2	23.6

Source: based on author's survey of students.

Thus, a majority of students feel that they learnt a lot during their studies and improved their knowledge levels, skills and abilities considerably. With respect to a variety of aspects of knowledge and skills, they felt 'stronger' or 'much stronger' when they were in the fourth year of their studies, compared to the levels with which they entered engineering institutions about three-and-a-half to four years earlier. This is true not only in case of knowledge of technology, and knowledge of engineering practices, but also with respect to abilities and skills for collaboration, problem solving, writing, communication, and leadership. As most projects nowadays require efforts of teams of engineers, collaboration and skills for collaboration are important in engineering education. About one-fourth of the students felt that there was no improvement or deterioration, while about ten per cent felt that there was deterioration in their skills, knowledge, and abilities in most of the identified areas. A majority of the students felt that their abilities to learn/communicate in any foreign language worsened. Many institutions in India might not offer opportunities for learning foreign languages, unlike in the western universities.

b) Assessments by institutions

We posed similar questions to the heads of departments/ deans to make an assessment of their graduates on various parameters of competence. Such an assessment may raise questions of bias. However, we also asked recruiters to provide their assessment of the average recruit, who is primarily a fresh graduate of a private college. The assessments are ranked low, medium and high. The results are shown in Table 2.

Table 2. Assessment of quality of their graduates by engineering institutions and by employers

	Engineering Institutions			*Employers*		
Competence of students in	Public	Government-Aided Private	Private	Firm 1	Firm 2	Firm 3
Core Science & Engineering	High	High	Medium	High	High	High
Science & Engineering knowledge in Major	High	High	Medium	High	High	High
English	High	High	Medium	High	High	High
Basic Use of Computers	High	High	High	High	High	High
Programming	High	High	Medium	High	High	Medium
Communication	High	High	Medium	High	High	High
Management	High	High	Medium	High	High	High
Sales	Medium	Medium	Medium	High	Medium	High
Organisation	High	Medium	Medium	High	High	Low
Teamwork	High	Medium	Low	High	High	High
Local networks	Medium	Medium	Medium	High	High	High
Global Networks	Medium	Medium	Medium	High	High	High
Problem solving	High	High	Medium	Medium	High	Low
Innovativeness	High	High	High	Medium	High	High
Multi-cultural awareness	Medium	Medium	Medium	Medium	High	Medium

Note: The last three columns refer to opinions of three IT firms in India, which together employ 235,000 persons as of April 2010. Firm 1 is a product company in ICT design, while firms 2 and 3 are IT services firms. Source: Based on author's survey of Heads/Deans and employers.

It appears that there is a remarkable similarity between the attributes of students assessed by recruiters and colleges. However, we need to keep in mind that these three firms were large employers and therefore had the "pick of the crop" from both public, and government-aided private institutions and even private colleges as well. The opinion of smaller firms which may actually be predominant in the market that offer lower salaries and hire more average students, might be quite different. Yet, at least as far as the large firms are concerned, it appears that the objective of engineering colleges to produce an employment-worthy graduate is being met.

c) Overall quality of education

Second, how do the students perceive the overall quality of education they were receiving? The response has been mixed. The non-response rate is high: one-third of the students did not answer this question or stated, "do not know" – more students in public institutions and traditional branches saying so, than their respective counterparts. If the non-responses are excluded, then out of the total, 66 per cent of the students felt that the quality was above average (including, good, very good and excellent). 30 per cent of the students felt the quality was just average, and according to a very small proportion of students the quality of the education they were receiving was poor/very poor (Figure 4).

Note: Non-responses/'do not know' are excluded (See Table 3). Source: based on author's survey.

Figure 4. Students' perceptions about the quality of their education

	Excellent	Very Good	Good	Average	Poor	No response/ Do not Know	Total
Institutions							
Public	3.2	8.4	31.5	15.9	3,1	37.9	100
Private	3.5	7.0	33.3	20.7	2.7	32.7	100
Branches							
Traditional	3.0	7.7	29.2	17.9	2.7	40.7	100
Modern	3.6	7.4	34.5	19.9	3.5	31.2	100
Total	3.4	7.5	32.7	19.2	2.8	34.3	100

Source: based on author's survey.

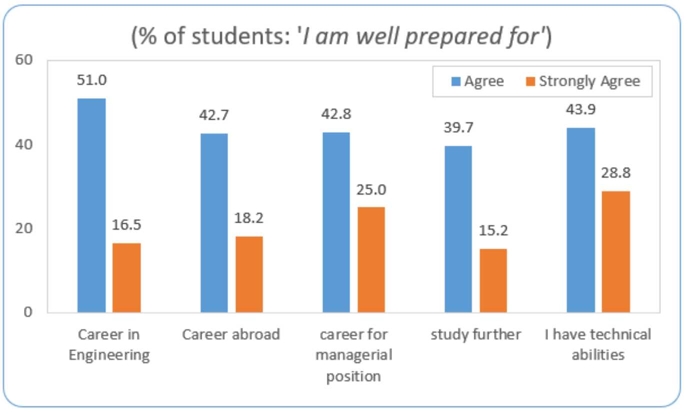
Table 3. Students' perceptions about quality of their education

Surprisingly, we also do not find much noticeable difference between the perceptions of students enrolled in public and private institutions or between traditional and modern departments (Table 3). Note that in Table 3, non-response category is included. There are differences between traditional and modern departments, though the differences are not very high. Those who felt the quality of their education is 'good' were also high in case of modern departments, which is about five percentage points higher than traditional departments. 45.5 per cent of students in modern departments felt that their education was good (and above), compared to 40 per cent students in traditional branches of engineering.

d) Preparedness for future and the level of confidence

Third, what about the confidence levels of the students regarding their preparedness to enter the world of work or go for further education? We asked in the survey, whether the student agrees with the statement "I am well prepared for …" Given the responses in the earlier sections, one may not be surprised to note that a majority answered that they agreed, with some answering that they strongly agree than those who had no opinion one way or the other. As high as three-fourths of the students claimed to have acquired technical abilities to enter the next phase of life. Two-thirds of the students felt that they were well-prepared for a good career in engineering; a similar proportion also stated that they were well prepared for managerial jobs; 60 per cent of the students were confident that they were well prepared for jobs in foreign lands; and only 54 per cent of the students 'strongly agreed' or 'agreed' with a view that that they were prepared for further education (Table 4). It is possible that the students are inherently not interested in further higher education or research for many reasons, the main being the academic environment in most places, which is not necessarily promotive of postgraduate education and research[5], and the second reason being the prospects of quick employment with the Bachelor's degree in engineering education.

The branches of study do not matter much with respect to confidence levels of students, as we find no big differences between students in modern areas and traditional departments. The only exception is, in case of preparedness to go abroad, a higher proportion of students (64 per cent) in modern branches claimed to have been well prepared than others (55 per cent: Table 4). Students might get influenced, while expressing this opinion by the general trends: larger number of graduates in electronics, computer sciences and IT-related engineering going abroad, compared to graduates in traditional branches of engineering.



Source: based on author's survey.

Figure 5. Confidence of students (in all branches in all institutions)

5 At the macro level, we found that very few engineering students go to postgraduate studies or research programmes (Tilak & Choudhury 2021).

Table 4. Confidence of the students on their preparedness for future

	Public		Private		Traditional Branches		Modern Branches	
	Agree	Strongly agree	Agree	Strongly agree	Agree	Strongly Agree	Agree	Strongly Agree
I am well prepared for								
Career in engineering	54.3	15.2	49.4	17.1	48.3	16.7	52.3	16.4
Career in abroad	46.4	14.7	40.8	20.0	39.2	15.6	44.3	19.4
Career goal for managerial position	46.7	20.4	40.8	27.4	42.4	21.6	43	26.5
Study engineering further	45.4	13.7	36.8	16.0	36.4	14.5	41.2	15.5
'I have technical abilities'	45.6	24.9	43.1	30.8	44	21.6	43.9	29.3

Source: based on author's survey.

While we do not find much difference between the students of public and private institutions, a marginally higher proportion of students in public institutions feel more confident; but with respect to technical abilities, students in private institutions feel better than others. Nearly two-thirds of students were also optimistic about the availability of jobs for graduate engineers in India in near future.

ii) Curriculum and course structure

Now we look at some selected aspects of curricula the students undergo during their studies. As per our survey and interviews, students in engineering studies take four to six courses and two to three courses of practical training which are laboratory-based, every semester for four years—a total of 36-40 courses and 16-18 laboratory-based courses in their undergraduate training. Students are in classrooms and/or laboratories for about 25 hours per week and 13 hours on computers. According to our interviews with students, they spend relatively little time working on their studies on their own at home. As shown later, students spend about 9 hours a week on homework. Tables 5 and 6 provide some important details on course structure in the IIT Madras.

Table 5: Computer Science Engineering: subjects studied

	Indian Institute of Technology Madras
Engineering Fundamentals	5
Computer Science classes	16
Senior Project	1
Minor (Engineering)	3
Mathematics	4
Physics	2
Chemistry	2
Humanities & Social Sciences	3
Total	36 (8 semesters)

Source: based on author's survey and interviews with students.

There is one lab for every two to three courses, depending on the institution, compared to each technical subject course having laboratory work associated with it in countries like the USA. Students in India are required to take more courses in sciences and engineering. For example, at IIT Madras, in the computer science engineering department, the core requirement (in sciences) consists of two classes in physics, two in chemistry and four in mathematics. The core subject classes are spread over three years. Further, with respect to course content, it has been found in our interviews that IIT Madras begins its programming sequence with training in Pascal, a language no longer taught in most American universities like Stanford, where the introductory course on computer science engineering emphasises modelling[6]. In India, it appears the focus is on numerical analysis, such as Gaussian eliminations or Euler's method. In IIT Madras, all the classes in the first year are in core sciences or the major. In the second year, the student takes one humanities class (out of 6) in each semester, and one more in the final year. The range of courses described under the term 'humanities' is wide, and includes the social sciences. While the class time for the humanities accounts for about six per cent, its share in total time spent is much less. There is a need to integrate courses from humanities and social sciences with engineering curricula as there is interdependence between technology and the social and economic foundations of the society, and as it will help the engineers' understanding of the societal norms of the workplace better (Sharan, 2004; Sheppard et al., 2009; Government of India, 2019).

Table 6. Structure of coursework and student study patterns

Category	Structure
Lecture : Laboratory	3 : 1
Supervised : Unsupervised	3 : 1
Total Hours/week on Major	40
Total Hours/week on Other Subjects	3
Lecture : Small Group Word	2 : 3:1
Total Units in Major, including prerequisites	88%

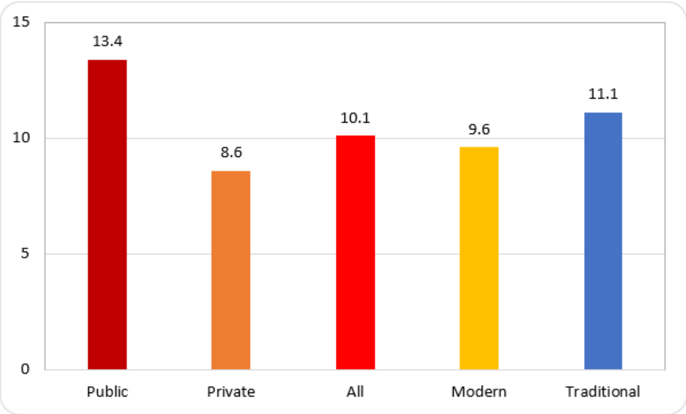
Source: based on interviews conducted by the author.

Table 6 gives further details on course structure. It shows the distribution of work between lecture courses and laboratory courses, lectures and group work, and time spent by students in classrooms/laboratories versus work outside the classroom. The ratio of classes to supervised labs is 3:1, and the ratio of unsupervised work (outside class hours) to supervised hours (in classroom lectures and laboratories) is 1:3. Students learn less on their own and depend extensively on classroom lectures. Within supervised teaching the lecture method dominates.

Let us look at some more details on the same, based on our four-state survey. First, what kind of courses are chosen by the students while studying engineering education for their undergraduate degree? The survey reveals that students tend to be focusing on major subjects only, as very few students were found to have opted for any courses outside their major/primary course. More students in public institutions took courses outside their majors than students in private institutions (Table 7). When it comes to students in modern branches of engineering, still fewer students took courses outside their major. Many institutions probably do not offer many courses outside their majors and students

6 Thanks are due to Martin Carnoy for providing inputs on US universities used here.

might not have many choices, or might not necessarily be aware of such probable choices. Note the high non-response rate, which is nearly 50 per cent.



Source: based on author's survey.

Figure 6. How many students have taken courses outside primary/major? (%)

The courses that engineering students can take in addition to major courses and laboratory courses are design courses, oral or written communication courses, professional courses such as business ethics, collaboration, entrepreneurship, leadership, management, preparation of projects for grants, international courses etc. Students can choose the type of course and number of courses in each category. Very few students seemed to have taken design courses, or courses in communication skills, or courses in business ethics etc. Fewer students (17 per cent) opted for international courses and those few might take just one such course (Table 7).

Secondly, even among the core courses, students have options to choose the number of majors, laboratory courses, design courses, communication courses, professional courses such as courses in ethics, leadership, and communication skills, and also international courses. We examined what is the course combination the students choose? We have found that 34 per cent of the students took 27 majors, 33 per cent 14 laboratory courses, and three design courses by one-fourth of the students.

Table 7. How many students have taken the following courses and how many courses?

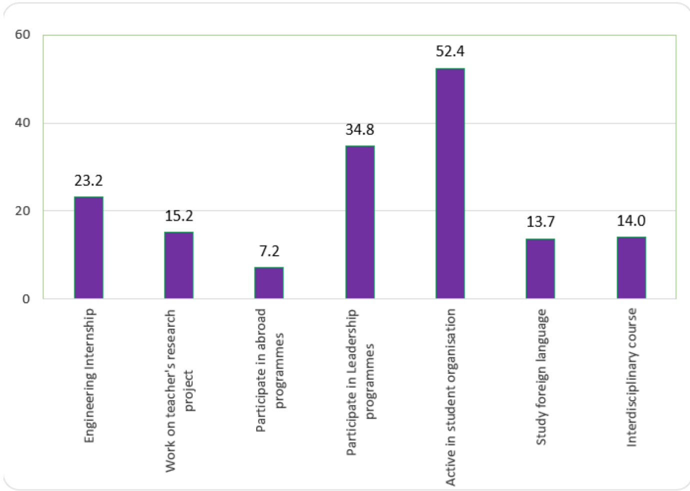
		Major courses	Laboratory courses	Design courses	Oral communi-cation courses	Profe-ssional courses	Inter-ational courses
By Type of Institution							
Public	No. of Courses	30	15	4	3	2	1
	% of Students	46.2	45.4	31.4	39.0	36.8	17.1
Private	No. of Courses	23	12	3	2	2	1
	% of Students	27.6	26.3	21.9	22.8	21.0	16.1
By Branches of Study							
Traditional	No. of Courses	25	14	3	3	2	1
	% of Students	26.6	25.4	21.8	21.4	20.0	12.5
Modern	No. of Courses	27	14	4	2	2	1
	% of Students	37.6	36.4	26.9	31.7	29.5	18.4
All	No. of Courses	27	14	3	2	2	1
	% of Students	34.1	33.0	25.3	28.5	26.5	16.6

Source: based on author's interviews with students.

Both in terms of proportion of students and in number of courses – majors, laboratory and design courses, students in public institutions excel as compared to the students in private institutions. While students in private institutions chose 23 major courses and 12 laboratory course, their counterparts in public institutions chose 30 major course and 15 laboratory courses. In public institutions, more than 45 per cent of the students took courses likewise, while the corresponding number was just above 25 per cent in private institutions.

iii) "Quality" as reflected in student practices

What are the major academic activities the students are engaged in? As the responses summarised in Table 8 show, hardly one-fourth of students were found to have ever participated in internship programmes.



Source: based on author's survey of students.

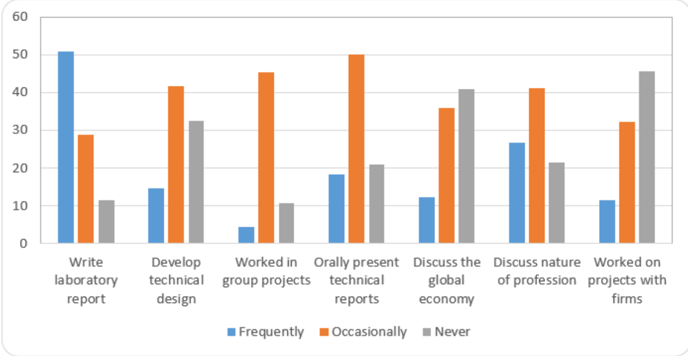
Figure 7. Students' participation in various study-related activities

Except for active participation in activities of student organisations, a vast majority of students were not involved in any activity and did not take up or get a chance to work in teachers' research projects, did not participate in any programme abroad, took any interdisciplinary courses of study in sciences, or studied any foreign language. As mentioned earlier, foreign languages are not offered in many institutions of engineering education in India. The students also did not seem to be interested in leadership programmes/classes. We also note that this was more or less the same situation in case of students enrolled in traditional and modern streams, differences between the two being very marginal. Students in public institutions were marginally at an advantage almost in every aspect than those who were in private institutions. On the whole, that more than 75 per cent of the students have not worked in any internship programme, and that more than 85 per cent of the students have not worked on any research project of their teachers must be a matter of serious concern, as they have direct impact on the quality of education they receive. The exception is only in the case of IITs and to some extent NITs. It is important to recognise that internships provide some valuable exposure to the industry and it is essential in transforming fresh engineering graduates to ready-to-use professionals (Prabhu & Kudva, 2016). After all, exposure to industry through a variety of ways helps in developing abilities to solve practical problems.

Table 8. Students' participation in internships, etc.

	Public	Private	Traditional	Modern	All
Internship in Engineering Projects	25.4	22.1	21.2	24.2	23.2
Work on Teacher's Research Project	17.0	11.8	15.4	15.1	15.2
Participated in abroad program	6.4	7.6	7.8	6.9	7.2
Participate in Leadership programmes/classes	36.9	33.7	32.1	36.0	34.8
Active in student organisation activities	55.1	51.1	50.4	53.4	52.4
Study a foreign language	14.1	13.5	13.4	13.9	13.7
Interdisciplinary course	16.6	12.7	14.4	13.9	14.0

Source: based on author's survey.



Source: based on author's survey.

Figure 8. Participation of students in academic activities (% of students)

Then, one may be curious to understand the academic activities of the students. Writing laboratory/technical reports seemed to be the major academic activity that the students were involved in. Laboratories are the best places that help in integration and synthesis of knowledge development, skills of solving problems and skills of collaboration. Learning from preparing lab reports is very valuable. The next important activity the students were engaged in was participation in group projects. Project-based and problem-based learning is generally regarded as very effective in engineering education. But they were least used practices as per our survey. Students also make oral presentation of the technical reports. Half the students never had any opportunity to work with any firm. Occasionally, students prepared some technical reports or participated in group projects. 37-43 per cent of the students never discussed issues relating to the global economy, markets etc., among themselves or with others. They might be least concerned with global (and even national) issues, being caught up with tight academic work relating to their studies. They do, however, discuss about their profession more frequently than other issues (Figure 8). It seems that a majority of the students seemed to be focused on their basic studies, and participated in the essential activities related to their academic studies. Laboratory and design experiences are valuable. Design projects offer opportunities to approximate professional practice. But involvement in designing of projects is limited. It is unfortunate that the students also do not seem to be much interested in co-curricular and additional activities that may also impact the overall quality of the students and their personality development.

Table A2 in the Appendix gives details by type of institutions and by branches of engineering. Students in public institutions were found to be performing better than their counterparts in private institutions with respect to writing laboratory reports, develop technical designs and work in group projects. With respect to other activities, there was no big difference between the two. Likewise, the students in modern departments were engaged more frequently than those in traditional departments in writing laboratory reports, working in group projects, developing technical designs and presenting oral reports. But in working with firms, or discussing global issues or their profession, the students in modern streams were involved less frequently.

It is often stated that students in engineering education do not take interest in social and political issues at national and global levels. We have not collected any information on this, except how frequently the students discuss global markets and the economy and related issues. However we collected information on students' voting behavior in general elections at the local/state/national levels, as a civic attribute. Only 55 per cent of the students have reported that they ever voted in elections. The differences between public/private institutions or departments were marginal. There were differences between the four states: while 70 per cent of the students voted in Delhi, only 51 per cent did so in Maharashtra. This is not much different from the voting behavior among the overall population in India in general.

iv) Time use by students

How do students in undergraduate engineering studies spend their time? Figure 9 shows the activities the engineering students spent their time on. These data support the findings in Table 9 showing that a much higher fraction of student time on academic work is devoted to attending classroom lectures and supervised work, rather than studying on their own or at home. The other time is distributed across socializing with friends, entertainment, sports, clubs, and 'other' activities such as voluntary/paid work, and transport.

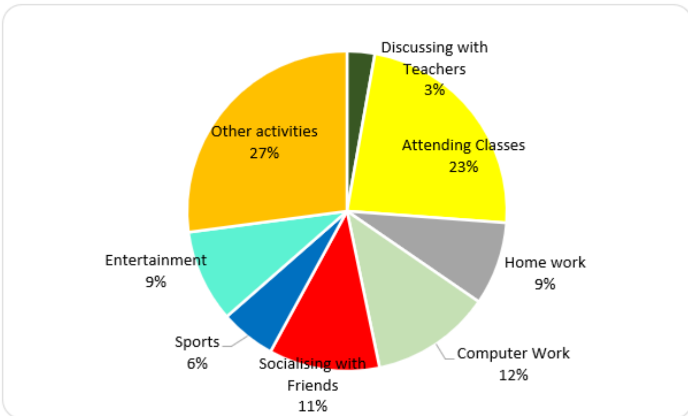


Figure 9. Time use by the engineering students in India

While we cannot comment whether this was an efficient pattern of time use or not, we note that the time spent on home work on self-learning is relatively very small, compared to time spent in classrooms. This also means that the classroom is the main place for learning by the engineering graduates like in the rest of higher education. Long ago, the Radhakrishnan Commission (1949) expressed concerns that mass lectures were the most common method in higher education and it was not supplemented by any regular work by students post-lecture (Mathew 2016). This continues to be the case.

Table 9. How do engineering students spend their time (hours/week)

Category of Activity	Delhi	Karnataka	Maharashtra	Tamil Nadu	Total
Attending classes / labs	17.9	29.8	27.4	33.4	27.0
Studying / homework	9.2	10.1	9.3	9.3	9.6
Socialising with friends	12.3	13.1	11.8	10.5	12.4
Meeting teachers outside classroom	2.5	2.4	1.8	3.0	2.3
Computer work	13.6	13.7	12.3	12.0	13.2
Volunteer work	2.9	3.4	2.7	4.4	3.3
Student clubs / groups	3.9	3.6	4.1	4.6	3.9
Sports/Exercise	6.2	6.7	6.0	6.2	6.4
Entertainment (movies, games, going out, etc.)	9.2	12.4	10.0	13.0	11.3
Paid Work	2.3	1.4	1.4	1.5	1.6
Transport	8.3	6.9	8.0	7.0	7.6
Total	95	113	106	112	108

Source: based on authors' student survey.

Much difference could not be found in students' time use between traditional and modern departments or between types of institutions. Even by gender, there are not much differences. But we find differences between the four different states in the total number of hours and their distribution as well. Students in Tamil Nadu used to spend 27 hours on attending classes/labs and 13 hours on entertainment, while students in Delhi spent 17 hours on classes/labs and nine hours on entertainment. Students in Tamil Nadu also spent less time than their counterparts in other states on computers and with friends.

v) Teaching practices and methods of evaluation

Teaching, learning and evaluation are inseparably linked together and the results depend upon the methods adopted for each of them. An important aspect on which we obtained valuable information from the survey of students and interviews with them refers to the pedagogic methods of teaching and methods of evaluation followed in their institutions, which have their own implications for quality of education.

a) Teaching and instructional practices

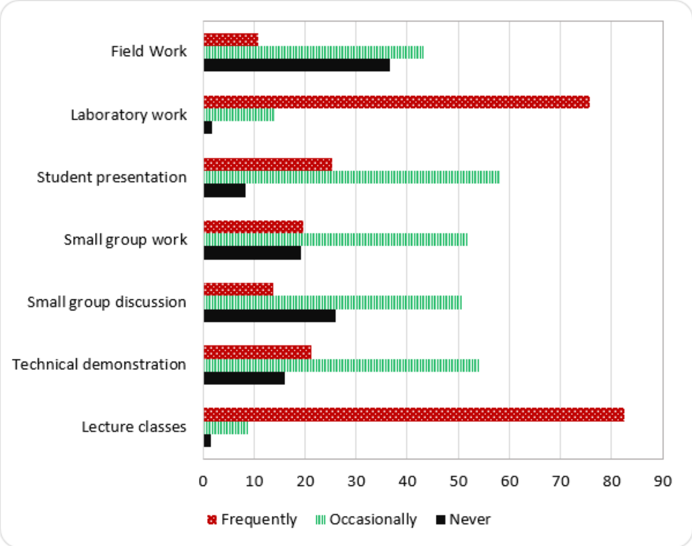
As the UGC (1973) listed, the objectives of teaching in higher education are manyfold, not just confined to transmission of knowledge[7]. To fulfil the objectives one needs an appropriate blend of various methods and practices in the delivery of education. Lectures in classrooms are the most common used method of teaching in all levels of education, including higher education in India. One may expect that engineering institutions may focus relatively more on technical demonstrations, laboratory work, field visits to industries, etc., as more effective pedagogic tools. But as per our survey, the traditional lecture method in the classroom, often known as chalk and talk method, seemed to be the most frequently used method in engineering colleges as well, whether it is teaching in traditional areas of engineering or modern (IT-related) areas or in public or private institutions. We noted during our survey that many institutions have smart classrooms, smart boards, computers and computer labs. The classroom lecture method is followed by use of laboratory for teaching as the second most common method of teaching. Other methods like students' oral presentations and discussions or work in small groups are only occasionally used. Technical demonstration is also only occasionally used by teachers. Field visits to industries and/ or work there is also a tool not used much in the teaching/ learning pedagogy in the traditional departments. On the whole, no major innovative pedagogic methods seemed to have been adopted in engineering institutions in India that will stimulate creative and imaginative thinking among the students or teachers. Presently, teachers seem to be primarily engaged with imparting technical knowledge and the teaching strategies are confined to structured problems, and demonstrations.

Compared to public institutions, private institutions appeared to be using technical demonstrations, discussions in small groups and laboratories more frequently than public institutions. But presentations by students and work in small groups were more frequently used in public institutions than in private institutions. Surprisingly, modern departments relied more on classroom lectures than traditional departments. With respect to every other method, traditional departments seemed to be performing better than modern departments.

b) Methods of evaluation

The method of evaluation of students' performance is generally regarded as one of the most important dimensions, reflecting on the quality of education. Evaluation or assessment is a very important part of the constructive alignment process in education. A well-designed evaluation system helps in understanding the level of mastery attained by students in a subject. The assessments help teachers in further improvement in their teaching practices. If the methods are defective, they may not be able to give any proper picture about the quality of teaching, quality of education or of the graduates. Year/semester-end examinations are the most traditionally used methods of evaluation in education in India. Continuous evaluation through assignments, group discussions, work in small groups, seminar presentations, project work etc., is extensively used in universities, but they

7 They are: to transmit a body of facts, figures and theories etc.; to create a grasp and an understanding of the theories and principles so that one may apply them to new situations; to produce a capacity of critically evaluating hypotheses when they are presented; to cultivate an open and flexible mind, so that one may retain the capacity to learn new things in future; to cultivate an urge for perfection, an appreciation of beauty and inclination to search for newer and better solutions to problems, to discover and invent; to train the mind for imagination, intuition and speculation into the realm of the unknown; to produce motivation and drive in the individual to result in capacity for sustained intellectual effort, to possibly cultivate qualities of leadership as well as teamwork; to cultivate specific manual, technical, intellectual and other soft skills; to train in the ability to communicate at a high intellectual level through specific media and so on (UGC 1973).

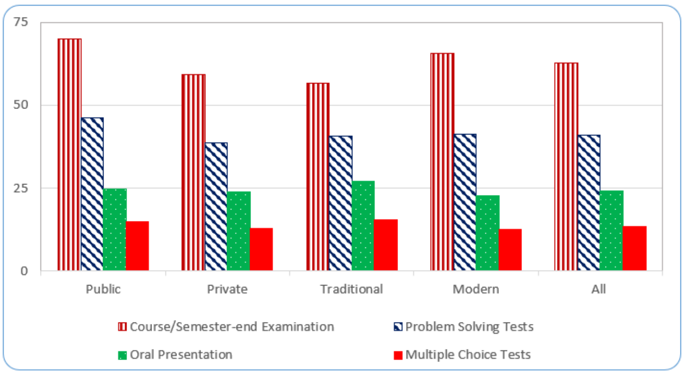


Source: based on author's survey of students.

Figure 10. Used and 'never used' teaching methods

mostly supplement semester/year-end examinations. Some reforms in examinations are attempted in higher education in India. It is widely agreed that a harmonious set of tests, quizzes, tutorials, home assignments, seminar presentations, group discussions, orals, project work, etc., have to be designed if an all-round assessment of the fulfilment of the objectives of a course has to be made. What are the practices in engineering institutions in India?

According to our survey, the semester-end examination was the most frequently used method in all institutions and branches. It is used more frequently in public institutions and also in modern departments than in private institutions and traditional departments respectively. Problem solving tests were the second most frequently used method, again more frequently in public institutions and modern branches than in others. In case of other methods, no big differences can be found between the several categories. Multiple choice tests are not common; they are least used. Oral presentations for evaluation were also only occasionally used.



Note: 'Occasionally used' are not included here. Source: based on author's survey.

Figure 11. 'Frequently' used methods of evaluation in engineering education, response by students (%)

It appears that the engineering education system, like the rest of higher education, needs drastic reforms in teaching and evaluation. The parameters of testing and evaluation that are being in practice need a relook and reorientation so that the system creates a new generation of technically competent, professionally knowledgeable and socially progressive knowledgeable citizens for the emerging national and global knowledge society. Now, based on the survey of the institutions and interviews with Deans/Heads of departments, let us look at a couple of related dimensions of quality of education.

vi) Faculty degrees and research orientation

A PhD degree is an essential condition for teaching in higher education institutions in India. A simple measure of faculty quality is the proportion of faculty with PhDs. But a large number of teachers in higher education in India do not have a research degree. Assuming that a research degree increases the quality of teaching and research in an institution, we examine how many teachers in engineering institutions possess PhD degrees. Except in the three IITs we surveyed, in the engineering colleges and universities, the proportion of PhDs among the teaching faculty varied between four and 26 per cent (Table 11).

Table 11. Faculty with PhD degrees in selected engineering institutions in three states in India

Engineering Institutions	Total Faculty	Total Students	Number of PhDs	Student/ Faculty	% PhDs in the Total Faculty
Karnataka (private)	348	4473	48	12.9	13.8
Karnataka (private)	381	5465	94	14.3	24.7
Karnataka (private)	107	1584		14.8	0.0
Karnataka (private)	91	1440	7	15.8	7.7
Karnataka (private)	106	1600	10	15.1	9.4
Maharashtra (public)	520	6000	470	11.5	90.4
Maharashtra (public)	165	3700	38	22.4	23.0
Maharashtra (public)	55	860		15.6	0.0
Maharashtra (private)	113	1671	9	14.8	8.0
Maharashtra (public)	141	1902	14	13.5	9.9
Maharashtra (public)	46	458	33	10.0	71.7
Maharashtra (public)	222	3082	38	13.9	17.1
Maharashtra (private)	222	3112		14.0	0.0
	28	1384	14	49.4	50.0
Delhi (public)					
Delhi (private	64	960	5	15.0	7.8
Delhi (private)	97	1440	5	14.8	5.2
Delhi (private)	137	1880		13.7	0.0
Delhi (public)	251	3500	129	13.9	51.4
Delhi (public)	136	2050	18	15.1	13.2
Delhi private)	86	1386	11	16.1	12.8
Delhi (public)	357	4382	351	12.3	98.3

Source: based on authors' survey of institutions.

However, these figures represent the percentages in the entire institution. Some departments might have higher proportions. It is likely that the departments like electrical engineering and computer sciences have much lower proportions of teachers with PhD degree compared to more traditional fields such as civil and mechanical engineering. For example, in one private college, of the 70 professors with PhDs, only five (seven per cent) were in electrical engineering, even though 17 per cent of total students were in that field of study. In a government college, of the 68 faculty members, 15 (22 per cent) were in electrical engineering and computer science, whereas 40 per cent of total students were in those two fields.

Table 12. Faculty in public versus private institutions

Proportion of	Public	Government-aided private	Private
PhDs in faculty	High	High	Low
Part-time faculty	Low	Low	High
Undergraduates	Low	Medium	High
Ratio of students/faculty	Low	Medium	High

Source: based on authors' interviews with Deans/Heads/faculty.

In general, the share of faculty with PhD degrees was lower in private institutions, averaging 13 per cent in our sample, versus 49 per cent for state and state-aided institutions. We note clear differences in the quality of faculty between public and private institutions. Public institutions are also able to attract better-qualified faculty, because of higher job stability and salary parity. The quality of an institution can be further assessed by observing the share of part-timers in the faculty. As summarised in Table 12, the part-timers were fewer in public and government-aided private institutions than in private self-financing institutions.

The quality of instruction is also likely to be influenced by the student-faculty ratio. According to the AICTE guidelines, it is expected to be 15 students per faculty member. In our interviews, this ratio was seen to have been largely met by all institutions, and the median was 14.62. However, the ratio was higher in private institutions than in state-aided colleges, which in turn was higher than in public institutions. A major reason for having relatively few teachers with PhDs in engineering institutions is the more general shortage of PhDs in general and in engineering education in particular. PhD programmes are available in public universities, and in case of engineering, almost exclusively in IITs and NITs and some universities, but annual production of these institutions is extremely small in number. They hardly cater to the other needs of even government engineering colleges in the entire country. Private institutions, both aided and self-financing, tend to focus more on undergraduate education, while public institutions which are also relatively older have a mandate to develop postgraduate education and research programmes. The average proportion of undergraduate students in the total enrolment was 76 per cent in state institutions and 94 per cent in private institutions in the country as a whole.

Although having a PhD does not necessarily imply that a teacher will be a more competent teacher, some positive relation between completion of a research degree and being able to teach a subject more competently can be expected, even at the undergraduate level. If this is the case, it seems to be difficult in the future to increase the quality of undergraduate engineering education significantly, unless some major initiatives are taken to promote research programmes and teacher recruitment.

4. Summary and concluding observations

Based on a survey of about 7,000 students and heads/deans in 48 engineering institutions in India, this paper presented students' perspectives on the quality of undergraduate engineering education in India. Perceptions are subjective; but have their own special significance. The analysis presented here covered nearly a dozen aspects of quality of education, and the findings are described in detail. Quality is multi-dimensional, but the coverage of aspects here is not exhaustive, as the analysis is constrained by the data available in the survey. Certain important pedagogical and curricular aspects were kept outside the framework of the given study, given the limitations of the researchers' interests and specialisations. Also any triangulation of the evidence analysed here, contrasting the available general perceptions or with available macro level quantitate data, has not been attempted. Yet the survey yielded some valuable information and the analysis presented here highlights a few new aspects, some of which are otherwise assumed. That the survey findings are different from market/general perceptions itself is an important point that is being made here.

Of all, most strikingly, in contrast to predominant views of the experts and others, engineering students who were interviewed in a wide range of institutions, including many private ones, appeared quite satisfied with their education and with their choice of engineering discipline and the institution. This is largely the case whether they are in prestigious institutions like the IITs or in less notable private institutions. As far as these students are concerned, the higher engineering education system has done "right" for them. How do we reconcile these somewhat highly positive views of the students with the general gloomy perceptions and perceptive views based on rigorous analytical studies of the experts and committees on engineering education in India, all of which condemn engineering education in India as deplorable in quality.

The 'overall' assessment of quality of education/institution by the students presented here is not really a 'summative' assessment, as on several individual parameters, students admitted otherwise. For example, a majority of students reported not to have participated in internship programmes, or got any exposure to industry, or got any opportunities to participate in research projects, or in leadership programmes, and so on. Students have also reported that they did not develop technical designs, or participate in projects with firms, etc. They have also mentioned that classroom lecture is the most relied method of teaching and semester/course end examination the main tool of evaluation. The question remains whether at all the students know that these are indeed not positive aspects of their education. It is likely that students are aware of some of these problems, but have reconciled to the situation to the extent of viewing the systems as satisfactory or good or even very good. After all, there was no choice for the students. Clearly no strong evidence could be found from the survey to say that a majority of students have acquired essential attributes of engineers for the twenty-first century that include strong analytical skills, practical ingenuity, creativity, mastery of business and management – awareness of interdependence between technology and the social and economic foundations of the society (Sheppard et al., 2009). At least some students are aware of these aspects and their expectations and aspirations, accordingly, are conditioned[8]. Further, students might also feel hesitant to admit that they did not learn much during their studies. So many reported that their current levels of knowledge and skills are 'stronger'/'much stronger' than what they were earlier and that they were satisfied with the overall quality of education they received.

While there is no basis to doubt the integrity and honesty of the students, though some feel that many private institutions do not encourage, in fact, prohibit, their students or faculty to speak honestly about their institutions[9], one has to note that given the asymmetry of information, students' knowledge of 'good quality' engineering education, what a high quality institution like, say an IIT in India looks like, let alone world class universities abroad, and even the labour market conditions in the country and at global level, including the professional knowledge, skills, abilities, competencies, attitudes and other values that the modern employers value, may not necessarily be of a reasonable level[10]. Immediately after their senior secondary level examination, students join a particular engineering college/ university, having no opportunity to interact with students and faculty of other (good and bad) institutions, as there are no formal horizontal or vertical linkages between the institutions. Students might not get many opportunities to interact with outsiders. Second, they have not yet entered the labour market, and with little participation in engineering internships and similar programmes that might provide some exposure to the world of work, they are yet to understand what the profession requires. Hence their expectations and aspirations may not be high. For the same reason, the students' perceptions on some of the issues may have to be discounted. So one extreme interpretation is: many students are like frogs in the well, and are very happy with what they have, without necessarily knowing what is good, and what is going on outside.

An alternative explanation can be as follows: the expert's conclusions are based on an examination of input indicators like the quality of teachers and infrastructure, process indicators such as methods of teaching and learning, and evaluation, and outcomes such as employability and graduate attributes. In contrast, it is likely that the students' views are essentially based on certain other outcomes: they are assured of a degree, which has an immediate value in the market – the labour market as well as the marriage market, besides enhancing the social status. The experts might be concerned, for example, with PhD degree holders among faculty, and the research output of the faculty. Students may be least bothered about these aspects; they would be content if a teacher takes the class and finally helps them in going through semester/year-end examinations successfully, which an un-/under-qualified instructor in a coaching institution might as well do[11]. The experts might be interested in adoption of sustainable knowledge development practices, but the students may be worried about their immediate success in examinations and in securing employment. The experts' long term considerations might not figure in students' short term perspectives. Thus the expectations and considerations of the experts and the students while making their respective assessment of quality of education can be different.

Even though the study does not finally resolve the differences between the two perspectives, it raises the question for further research. While it cannot be concluded that one is right and the other group is wrong, for which further investigation is needed, we feel that both perspectives are important for a proper understanding of the quality of engineering education in India.

The students' perspectives that we reported here may compel the researchers to widen their approach to study quality-related problems, and administrators and policy makers to rethink on their perspectives and policy initiatives. Further, the students' responses to the queries on teaching learning practices – teaching methods (e.g., the predominant use of the classroom lecture method), and methods of evaluation (e.g., extensive reliance on semester/year-end examinations), absence of internship programmes, lack of opportunities for participation in research projects, lack of sufficient faculty with doctoral degrees, high numbers relating to part-time teachers, etc., would call for effective interventions by the policy makers, planners, regulators, and the institutions to enhance the overall quality of the learning environment in engineering institutions in India. The public-private differences and also the differences between modern and traditional branches highlighted here also help in identifying the areas of special focus. Some of these details are generally lost in macro averages. The findings and insights provided here may form timely, relevant and important inputs in implementation of the National Education Policy 2020, which focuses extensively on improvement of quality in higher education in general and professional and technical education in particular.

8 For the same reasons, students from 'tier 2' and 'tier 3' colleges have lower expectations on future employment conditions and salaries (Aspiring Minds 2019). See Tilak & Choudhury (2021).

9 Quite a few private institutions – universities and colleges in the National Capital Region of Delhi and other states, have flatly refused permission to conduct our survey in their institutions, despite our having an official letter seeking their cooperation in the conduct of the survey.

10 In a study on Karnataka, based on student survey of students, it was concluded that students could not connect to the industry expectations (Kulkarni 2017).

11 Many of the students undergo coaching from such institutions while preparing for common entrance examinations for admission in engineering institutions.

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Appendix

Table A1. *Current knowledge, abilities and skills, compared to the time of entry into this institution*

	Much weaker	Weaker	Same	Stronger	Much stronger	No Response/ do not know	Total
Public Institutions							
Knowledge of Technology	2.5	4.3	11.2	55.0	21.7	5.4	100
Knowledge of Engineering practices	1.5	4.0	13.6	59.1	15.7	6.2	100
Foreign language ability	7.0	11.2	48.9	19.8	6.1	7.0	100
Leadership ability	1.9	3.6	22.6	43.0	22.5	6.4	100
Writing skills	1.8	4.5	22.6	47.8	17.1	6.1	100
Academic ability	3.1	6.4	21.7	38.3	20.9	9.7	100
Knowledge of new technology	2.3	5.1	18.4	45.9	14.2	14.1	100
Knowledge about global markets/economies	2.9	6.6	29.2	40.8	12.5	8.0	100
Oral communication skills	1.8	4.9	21.6	45.9	18.3	7.6	100
Problem solving ability	1.5	4.4	16.3	41.7	24.6	11.4	100
Collaborative ability	1.9	3.0	14.5	41.2	30.9	8.5	100
Interest in lifelong learning	3.2	5.5	18.6	42.3	22.9	7.5	100
Intercultural skills	2.3	5.0	26.0	41.8	17.2	7.8	100
Entrepreneurial skills	3.0	4.9	26.4	39.9	15.8	10.0	100
Private Institutions							
Knowledge of Technology	2.3	3.9	12.8	57.6	15.2	8.2	100
Knowledge of Engineering practices	1.7	4.2	14.7	56.4	13.9	9.1	100
Foreign language ability	8.7	12.7	46.0	16.6	5.9	10.2	100
Leadership ability	1.8	4.8	22.9	42.5	18.8	9.2	100
Writing skills	1.7	4.5	21.9	44.2	18.9	9.0	100
Academic ability	3.2	9.0	21.5	35.1	21.6	9.6	100
Knowledge of new technology	2.2	6.2	24.3	36.2	18.5	12.6	100
Knowledge about global markets/economies	3.5	7.7	29.8	34.4	13.7	11.0	100
Oral communication skills	2.1	5.3	22.9	35.6	20.9	13.2	100
Problem solving ability	1.6	3.5	16.0	42.3	20.2	16.5	100
Collaborative ability	1.5	3.2	14.4	42.9	26.4	11.6	100
Interest in lifelong learning	3.1	5.4	19.5	38.3	23.2	10.6	100
Intercultural skills	2.2	5.1	25.2	36.1	19.7	11.7	100
Entrepreneurial skills	2.8	5.4	26.0	35.2	16.3	14.3	100
Traditional Departments							
Technology knowledge	2.9	3.8	12.7	57.5	13.4	9.6	100
Engineering practice knowledge	1.7	3.7	15.4	54.3	13.9	11.1	100
Foreign language ability	9.0	13.6	40.7	18.8	5.7	12.2	100
Leadership ability	2.0	4.5	24.0	39.6	18.8	11.3	100
Writing skill	1.6	4.2	21.4	44.2	18.1	10.6	100
Academic ability	3.1	8.0	19.1	35.5	20.8	13.6	100
Knowledge new technology	2.6	5.8	22.1	36.3	16.1	17.1	100
Knowledge about global market/economies	3.8	7.4	27.3	35.2	12.1	14.3	100
Oral communication skill	1.9	5.5	22.2	37.5	17.5	15.4	100
Problem solving ability	2.1	3.8	15.8	42.1	17.9	18.3	100
Collaborative ability	1.6	3.4	14.2	42.3	23.9	14.6	100
Interest in lifelong learning	2.6	5.1	18.6	38.8	21.2	13.7	100
Intercultural skill	2.2	4.8	24.1	36.5	17.7	14.8	100
Entrepreneurial skill	3.1	5.0	24.9	33.3	16.0	17.8	100
Modern Departments							
Technology knowledge	2.1	4.1	12.1	56.3	19.2	6.2	100
Engineering practice knowledge	1.6	4.3	13.9	58.6	14.8	6.8	100
Foreign language ability	7.7	11.6	49.8	17.2	6.0	7.7	100
Leadership ability	1.8	4.4	22.3	44.1	20.6	6.9	100
Writing skill	1.8	4.6	22.5	45.9	18.4	6.8	100
Academic ability	3.2	8.3	22.7	36.5	21.6	7.9	100
Knowledge new technology	2.1	5.8	22.4	40.9	17.5	11.3	100
Knowledge about global market/economies	3.1	7.3	30.7	37.1	13.8	8.0	100
Oral communication skill	2.0	5.0	22.6	39.8	21.2	9.5	100
Problem solving ability	1.3	3.8	16.2	42.1	23.4	13.2	100
Collaborative ability	1.7	3.0	14.5	42.4	29.7	8.7	100
Interest in lifelong learning	3.3	5.6	19.5	40.0	23.9	7.7	100
Intercultural skill	2.3	5.2	26.1	38.7	19.4	8.4	100
Entrepreneurial skill	2.8	5.3	26.6	38.4	16.2	10.7	100
All							
Technology knowledge	2.3	4.0	12.3	56.7	17.4	7.3	100
Engineering practice knowledge	1.6	4.1	14.3	57.3	14.5	8.1	100
Foreign language ability	8.1	12.2	47.0	17.7	6.0	9.1	100
Leadership ability	1.8	4.4	22.8	42.7	20.1	8.2	100
Writing skill	1.7	4.5	22.1	45.4	18.3	8.0	100
Academic ability	3.1	8.2	21.6	36.1	21.3	9.7	100
Knowledge new technology	2.3	5.8	22.3	39.4	17.1	13.1	100
Knowledge about global market/economies	3.3	7.3	29.6	36.5	13.3	10.0	100
Oral communication skill	2.0	5.2	22.5	39.1	20.0	11.3	100
Problem solving ability	1.6	3.8	16.1	42.1	21.7	14.8	100
Collaborative ability	1.7	3.2	14.4	42.3	27.9	10.5	100
Interest in lifelong learning	3.1	5.4	19.2	39.6	23.1	9.5	100
Intercultural skill	2.2	5.1	25.4	38.0	18.9	10.4	100
Entrepreneurial skill	2.9	5.2	26.1	36.8	16.1	12.9	100

Source: based on author's survey of students.

Table A2. *Participation of students in academic activities*

	Frequently	Occasionally	Never	No response/ do not know	Total
Public Institutions					
Write laboratory report	56.7	28.2	8.3	6.8	100
Develop technical design	16.3	49.1	26.3	8.4	100
Worked in group projects	41.1	40.4	11.2	7.4	100
Orally present technical reports	17.0	54.3	20.3	8.4	100
Discuss the global economy	12.3	35.7	43.4	8.6	100
Discuss nature of profession	26.5	41.9	23.4	8.2	100
Worked on projects with firms	11.0	34.1	46.7	8.2	100
Private Institutions					
Write laboratory report	47.9	29.1	13.2	9.8	100
Develop technical design	13.6	38.0	35.9	12.6	100
Worked in group projects	30.9	48.0	10.6	10.5	100
Orally present technical reports	19.1	48.1	21.4	11.4	100
Discuss the global economy	12.2	36.2	39.8	11.9	100
Discuss nature of profession	26.9	40.8	20.3	12.0	100
Worked on projects with firms	11.9	31.2	45.3	11.7	100
Traditional Departments					
Write laboratory report	45.6	30.7	11.9	11.8	100
Develop technical design	13.9	37.5	32.8	15.8	100
Worked in group projects	28.6	46.4	12.7	12.3	100
Orally present technical reports	16.8	47.2	20.8	15.2	100
Discuss the global economy	13.4	35.5	36.6	14.6	100
Discuss nature of profession	27.1	38.9	19.1	14.9	100
Worked on projects with firms	12.1	33.9	40.5	14.0	100
Modern Departments					
Write laboratory report	53.2	28.0	11.4	7.4	100
Develop technical design	14.8	43.7	32.5	9.1	100
Worked in group projects	36.9	45.0	9.9	8.2	100
Orally present technical reports	19.2	51.5	21.2	8.2	100
Discuss the global economy	11.7	36.2	43.0	9.1	100
Discuss nature of profession	26.6	42.3	22.3	8.8	100
Worked on projects with firms	11.4	31.6	48.0	9.0	100
All					
Write laboratory report	50.9	28.8	11.6	8.8	100
Develop technical design	14.5	41.8	32.6	11.1	100
Worked in group projects	34.3	45.4	10.8	9.5	100
Orally present technical reports	18.4	50.2	21.1	10.4	100
Discuss the global economy	12.2	36.0	41.0	10.8	100
Discuss nature of profession	26.8	41.2	21.3	10.7	100
Worked on projects with firms	11.6	32.2	45.7	10.5	100

Source: based on author's survey of students.

Table A3. *Teaching methods used in public versus private engineering institutions*

	Frequently	Occasionally	Never	No response	Total
Public Institutions					
Lecture classes	83.3	9.1	2.0	5.7	100
Technical demonstration	18.9	56.8	16.6	7.7	100
Small group discussion	12.9	51.0	28.2	8.0	100
Small group work	24.7	51.7	15.7	7.8	100
Student presentation	30.0	53.7	9.3	7.1	100
Laboratory work	74.2	16.7	2.2	6.9	100
Field Work	11.4	44.3	33.9	10.4	100
Private Institutions					
Lecture classes	82.0	9.1	1.2	7.7	100
Technical demonstration	22.6	52.5	15.8	9.2	100
Small group discussion	14.1	50.7	24.9	10.4	100
Small group work	17.0	52.0	21.0	10.0	100
Student presentation	23.0	60.2	7.9	8.8	100
Laboratory work	76.7	13.0	1.7	8.7	100
Field Work	10.6	42.6	37.7	9.2	100
Traditional Streams					
Lecture classes	79.1	10.4	1.8	8.8	100
Technical demonstration	23.2	49.4	15.4	12.0	100
Discussion in small groups	16.0	47.8	23.8	12.4	100
Work in small groups	20.4	48.8	17.8	13.0	100
Student presentations	25.4	55.7	8.3	10.6	100
Laboratory work	73.4	14.6	1.9	10.0	100
Field Visit/Work (in industries)	14.7	50.5	23.5	11.4	100
Modern Streams					
Lecture classes	83.9	8.5	1.3	6.3	100
Technical demonstration	20.5	55.9	16.4	7.2	100
Discussion in small groups	12.7	52.1	27.0	8.3	100
Work in small groups	19.3	53.3	19.8	7.6	100
Student presentations	25.4	59.1	8.4	7.2	100
Laboratory work	76.9	14.1	1.8	7.2	100
Field Visit/Work (in industries)	9.0	39.7	42.7	8.6	100
All					
Lecture classes	82.4	9.1	1.4	7.0	100
Technical demonstration	21.3	53.9	16.1	8.7	100
Discussion in small groups	13.7	50.8	26.0	9.6	100
Work in small groups	19.6	51.9	19.2	9.2	100
Student presentations	25.4	58.0	8.4	8.2	100
Laboratory work	75.8	14.2	1.9	8.1	100
Field Visit/Work (in industries)	10.8	43.1	36.6	9.5	100

Source: based on author's survey of students.

Table A4. *Frequency in the use of methods of evaluation*

	Frequently	Occasionally	Never	No response	Total
Public Institutions					
Multiple Choice Tests	14.8	43.9	34.4	6.9	100
Test with Problem Solving	46.1	36.9	10.4	6.6	100
Course/Semester-end Examination	70.0	17.5	5.4	7.1	100
Oral Presentation	24.6	52.5	15.8	7.1	100
Private Institutions					100
Multiple Choice Tests	12.8	34.7	43.2	9.3	100
Test with Problem Solving	38.6	39.8	12.9	8.8	100
Course/Semester-end Examination	59.2	22.9	7.1	10.8	100
Oral Presentation	23.8	48.7	17.9	9.6	100
Traditional Branches					
Multiple Choice Tests	15.5	38.8	34.2	11.5	100
Test with Problem Solving	40.6	36.8	10.8	11.8	100
Course/Semester-end Examination	56.6	22.0	7.4	14.0	100
Oral Presentation	26.9	44.9	15.5	12.7	100
Modern Branches					
Multiple Choice Tests	12.6	37.4	42.9	7.1	100
Test with Problem Solving	41.3	39.7	12.6	6.4	100
Course/Semester-end Examination	65.7	20.7	6.2	7.5	100
Oral Presentation	22.8	52.3	18.0	7.0	100
All					
Multiple Choice Tests	13.5	37.8	40.2	8.5	100
Test with Problem Solving	41.1	38.8	12.1	8.1	100
Course/Semester-end Examination	62.9	21.1	6.5	9.5	100
Oral Presentation	24.1	50.0	17.2	8.8	100

Source: author's survey of students.