TEST Engineering & Management

January - February 2020
ISSN: 0193 - 4120 Page No. 5762 - 5769

Engineering Education Industry: Challenges and Strategy to Overcome These

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Article Info
Volume 82
Page Number: 5762 – 5769
Publication Issue:
January-February 2020

Article History
Article Received*: 18 May 2019*
Revised*: 14 July 2019*
Accepted*: 22 December 2019*
Publication*: 28 January 2020*

Abstract:
Engineering education industry is close to Rs. 54,000 crore industry in India. It was a comfortable industry, where once annual tuition fee is given by students, there is no pressure on the management to show output every month or quarter as is the case in other industrial sectors. This industry was booming till 2013 after which a decline has started and in the last 5 years students' enrollment has decreased by 14%. This enrollment is predicted to be less in the years to come posing a great threat to engineering education industry. Already hundreds of engineering colleges have closed down and there is threat to other colleges too. Root causes of the decline in enrollment of students have been identified and strategy to tackle the same have been suggested in this paper.

Keywords: *engineering education in India, science subjects, STEM*

I. INTRODUCTION

At the time of Indian Independence in 1947, there were merely 87 technical colleges (including architecture, polytechnics and pharmacy) in India with an intake of just 6,600 students [1]. Till 1980, most of the higher educational institutions were run by govt. but after that private players also came in this industry. In 2013-14, the number of technical colleges rose to 10,305 with an intake capacity of 37,24,731 students [2]. Enrolment in private colleges rose to 66.4% in the year 2018-19 [3].

Govt keeps hefty budgetary provision for higher education. In the 2019-20, Indian Govt. has kept a budget of Rs. 37,461 crore for higher education [4], around 10% of which will be used for the technical education only. Private colleges also charge substantial amount of fee from the students which comes to around Rs. one lakh per student per annum on the average. So, the total budget in the engineering education industry is close to Rs. 54,000 crore. Managements of private colleges have invested heavily and made good infrastructure for engineering education.

A decline in this industry started in the year 2013-14, and the enrolment of students for engineering discipline has been coming down every year. It has already dipped by around 14% in the last five years and future has become uncertain. This is the major challenge being faced in engineering education sector.

In this paper, causes of the decline in engineering education industry have been identified and a strategy has been suggested to meet this challenge.

II. RESEARCH METHODOLOGY

Literature on the subject of various countries and specially India was studied besides establishing interaction with a large number of stake holders. Official documents of the governmental and autonomous bodies of the following agencies were studied:

- University Grants Commission (UGC), All India Council for Technical Education (AICTE), National Council for Education, Research and Training (NCERT)
- Finance Ministry of India (Indian Budget for 2019-20)
- Ministry for Human Resource Development (MHRD), Govt. of India (for Survey reports AISHE on higher education institutions on India and prospective National Education Policy 2019)

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Interaction was also established with the following officials:

- Experts in the field of education and corporate sector
- Management and faculty of engineering colleges
- Principals of 10+2 schools
- Students of primary, middle and higher secondary schools

Besides this, research work done by expert faculty and research scholars on the subject was referred to and discussed with the scholars before reaching any conclusion.

III. IMPORTANCE OF ENGINEERING EDUCATION

From stone age till date, human beings have evolved themselves at each step through a journey of innovations and improvements in each field. Started with hunting, learnt to make houses for their own living, discovered fire and metals till they reached the stage of industrial revolution in 18th century. Importance of engineers and engineering technology brought automation at the front foot. Discovery of electricity and invention of telecommunications, computers, mobile phones, internet etc. are all due to the hard work of scientists and engineers.

Could this have been possible, had scientists and engineers not there in the society. Not at all. Even now if these science skills become extinct, then further progress of humanity will stop or will be very slow.

Though the subjects of arts, commerce, humanity etc. are also important but without the study of science and engineering, further progress of humanity will be slow. So, it is essential for the society to have sufficient number of scientists and engineers so that progress of humanity is at the proper pace for the benefits to be reaped by the complete society. Thus, engineering education is very important for a country to grow.

In USA too, it was a growing concern that sufficient number of students were not showing interest in STEM (Science, Technology, Engineering and Mathematics) subjects [5]. Even those who take these subjects do not attain any proficiency. USA, which is claimed as one of the top countries producing innovations and patents, does not find its students performing well in math and science subjects. This concern has been aired on many occasions in USA. Similar is the case in many other developing countries [6].

IV. EDUCATION SCENE IN THE YEARS 2014 TO 2019

Survey report for the year 2014-15, released by MHRD, Govt. of India shows that there were 3,42,11,673 students enrolled in higher education in all disciplines in the year 2014-15 [7]. As population of the country was increasing at an average rate of 1.10% per year [8], and with the thrust from government side on improving the Gross Enrolment Ratio, the numberof students in higher education increased considerably to 3,73,99,388 in the year 2018-19, thus achieving an overall growth rate of 9.3% in the last four years [3]. However, on the engineering education side the case has been different where the number of students enrolled has decreased by 14% i.e. from 45,44,330 to 39,06,449 in the same period. Decrease in number of students, year-wise, is shown in **Table I** [3].

Even the number of students appearing in Joint Entrance Examination JEE Mains (earlier called All India Engineering Entrance Examination Mains) for taking admission to prestigious engineering colleges of the country like IIT, NIT, IIIT, GFTI etc. has been decreasing since 2014 as is evident in **Table II** [9] - [11]. This is a cause of worry for the management of engineering institutions and the country as a whole.

V. SIZE OF ENGINEERING EDUCATION INDUSTRY

Currently, out of all the students pursuing higher education, 66.4% of them are enrolled in private colleges [3]. And accordingly, around 26 lakh students are studying engineering in private engineering colleges only. Private colleges are either self-financing type or get aid from govt. for running their engineering education. However, the average tuition fee charged from the engineering students is

Table-I: Enrolment in Engineering during 2014-19

S. No.	Year	B.Tech	M.Tech	Total
1	2014-15	42,54,919	2,89,311	45,44,330
2	2015-16	42,03,933	2,57,361	44,61,292
3	2016-17	40,85,321	1,60,888	42,46,209

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4	2017-18	39,40,080	1,42,081	40,82,161
5	2018-19	37,70,949	1,35,500	39,06,449
Total Decrease in Enrolment during 2014 and 2018				6,37,881
Percentage Decrease in enrolment during 2014-18				14%

Table-II: Students appeared in JEE Mains

S.No.	Year	Number of students appeared in JEE Mains (in Lakhs)
1	2013	14.62
2	2014	13.57
3	2015	13.05
4	2016	11.95
5	2017	11.86
6	2018	11.48
7	2019	9.35
Decrease in Number of Students during 2013-19		5.27
Percent Decrease during 2013-19		38.10%

Rs. One Lakh per annum besides other mandatory charges. So management of private colleges charge to the tune of Rs. 26,000 crore every year from the students. Besides this, there are other engineering courses like MCA, bio-technology course and polytechnics, which when clubbed together take the budget to around Rs. 50,000 crore only in private sector. Govt. also spends substantial amount of money on its own engineering colleges. In the budget of 2019-20, Indian govt. has earmarked Rs. 37,461 Crore for higher education [4].As number of engineering students is around 10% of the total enrolment, the amount earmarked for engineering education by the government of India is approximately Rs. 3,700 crore. So, the engineering education industry, for both private and government colleges hovers around Rs. 54,000 crore or so. If engineering related education at polytechnic level or MCA are considered, then this industry will be much bigger that Rs. 54,000 crores.

Private institutions have already raised sufficient infrastructure to cater for the students' need. In the meantime, enrolment in engineering education has decreased by 14% at UG and PG level during the period 2014-15 to 2018-19 thus losing revenue due to around 6.37 lakh students [11]. This decrease in students' strength, on one hand, is loss of revenue to the institution and, on the other hand, the already built infrastructure is being wasted out. In some of the institutions, the enrolment has been too low to be economical and they decided to close down their institutions. As per AICTE, 54 colleges asked for progressive closure during the year 2018-19 and figure went to 56 in the year 2019-20 [1]. This is cause of worry, solution for which needs to be found out.

IV. PROBABLE CAUSES OF DECLINE IN ENGINEERING EDUCATION INDUSTRY

After clearing 10th standard, a student is free to choose one of the three streams viz. Science, Commerce or Arts/Humanity. Within Science stream too, one has to opt for engineering or medical stream and accordingly choose the subjects. A student who plans to pursue engineering degree, has to choose, Physics, Chemistry and Mathematics as mandatory subjects in 11th standard.

Out of all the subjects in 11th standard, it is seen that, Mathematics and Physics are perceived as comparatively difficult subjects. One has to remain regular in studies from class I to 10th to understand the topics in 11th standard [12] - [14].

Interaction was established with a large number of school as well as engineering students. Most of them feel that the subject Mathematics is not exiting. Teachers generally resort to lecturing and do not link the subject with the day to day life. Similar is the case with Physics. Some students feel that too much of theory, too many formulae, laws and rules make the subject uninteresting at school level. Hence most of them prefer to avoid opting for Mathematics and/or Physics which make them ineligible for engineering stream.

Secondly, as per the National Employability Report -2019 by Aspiring Minds, 80% engineering graduates are not place able at the end of their 4-year degree programme in India and do not get job [15]. This percentage has remained almost same and not improved for very many years. Even if the ones who get the job, it is of menial nature, which they could, otherwise have also got in case they had gone in for an easier 3-year course of arts or humanities. This is another reason that students, of late, are avoiding taking science or mathematics subjects at 11th standard.

In the State of Punjab, during the session 2018-19, out a total of 1,56,979 students who took admission in 11th class in government schools, under Punjab State

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Education Board, only 14,546 students (9%) took science subjects [16]. Similar was the case in private schools where out of 1.6 lakh students, only 34,000 opted for science subjects. So, in the year 2020-21 when these students are to choose for the professional course, a very less percentage of science-stream students would be available who may opt to go for medical, nursing or pure sciences besides engineering degree.

It is a very disturbing trend as engineering education is likely to be affected by this trend in future too.

V. IMPACT ON THE COUNTRY'S ECONOMY

More and more students of 11th class have been shying away from science subjects and opting for non-science subjects like commerce, arts or humanities in the recent years. However, when it comes to improving the standard of living of humanity, country needs scientists and engineers who are required to do research and innovate better techniques. But if the number of science-stream students are less, then progress will be very slow. Today if humanity is enjoying the fruits of computers or electricity or air-conditioners, it is due to the innovations done by scientists and engineers. Hence the trend of shying away from science subjects will make the country devoid of scientists, engineers and doctors. Or only the low-merit students or those who have less interest in science will become scientists and engineers. This may lead to catastrophe for the country, which at the later stage, has to depend on foreign countries for all the innovations and newer technologies. Hence, there is need to change the education system in such a way that maximum students get interested in science subjects at the school level and become scientists, engineers and doctors.

VI. STRATEGY TO REVIVE ENGINEERING EDUCATION INDUSTRY

It is clear from above that all the countries must keep their students interested in science subjects. For this all stake holders including Govt. of India, UGC, AICTE, universities and the higher educational institutions as well as the parents have to take a proactive action. Suggested role of each of these agencies is explained in succeeding paragraphs.

A. Role of Govt.

During 2017, Govt. of India decided to come out with a compressive education policy covering all vital issues so as to prepare children and youth to meet variety of present and future challenges. Accordingly, Ministry of Human Resources Development, Govt. of India came out with a Draft National Education Policy (NEP) 2019 which was uploaded on the internet for getting inputs from all the stake holders [17]. This draft policy claims to meet the guiding goals of accessibility, equity, quality, affordability and accountability. The specific issue of generating interest in subjects of science in the minds of these students are not very specifically covered. So following suggestions are submitted:

- Science subjects should be introduced at early childhood days and should be made simple to generate interest among students.
- More practical activities must be included in science and mathematics subjects.
- Mode of teaching at school level, which is currently simple lecturing, be changed to active learning. Each topic should be linked with the physical world to generate interest in students. Active learning should be resorted to.
- Mathematics and science subjects should be made compulsory upto 10th class and should also remain as mandatory subject or non-credit courses during 11th and 12th class.
- Special scholarships, suitable incentives and state/national level competitions should be introduced at school level which encourage students to opt for science subjects at 11th standard.
- All teachers should be able to teach science and mathematics subjects at basic level.
- Laboratory infrastructure should be given priority in all school including primary schools.
- Additional funds be earmarked for STEM subjects as is being done by many advanced countries. It should also form part in the NEP 2019.

B. Role of UGC/AICTE/NCERT

During February 2018, AICTE published Model syllabi for each semester of engineering courses which set guidelines for all the engineering colleges to adhere to [18]. Similarly, NCERT whose main role is to advise center and state governments on school education, must bring out guidelines for the school education in such a way that give special thrust to science subjects [19]. It should also prepare model text books for early education classes which generate

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interest in science subjects among students from very beginning. Course syllabus and the method of teaching should be made simple and it should appear to a student like tasty food which he/she would love to adopt. Besides this active learning should form part of teachers' education so that simple lecturing is avoided.

In the model syllabus for engineering students, AICTE has reduced the credit-hours in each semester [18].Physics which was being taught in 1st and 2nd semesters with less number of credits, is now being covered in one semester only, but with higher credit-hours. Interaction with the students reveal that they feel burdened with more credit-hours in one semester and consider it as a heavy dose. Same is the case with Chemistry. Students interacted desire that status quo should be maintained as far as the subjects of Physics and Chemistry are concerned and it is recommended that AICTE look into this aspect and if possible, revert back to the old system for these subjects.

To generate interest in the science subjects among school children, AICTE should make a policy in which all engineering colleges be directed to take on outreach programs for them. Each engineering college must adopt at least 10-20 primary, middle or higher secondary schools in the vicinity, invite the students to their college, show them the laboratories and the live projects being developed. Faculty and students should also visit the schools to motivate the children for taking on STEM subjects.

There are over 900 universities in India which are controlled by UGC [20]. Each university has various colleges under it viz. constituent, affiliated and autonomous colleges. There are over 40,000 institutions of higher education as on today. Suitable guidelines be issued by the UGC to the universities for taking steps to enthuse interest in STEM subjects at college level. The live work being done by them must be advertised on/offline so that it reaches the masses, particularly to the school students and their parents. That way interest in science subjects will gain momentum at school level.

C. Role of Universities/Institutions

Universities and private engineering colleges are the major stake holders which are the affected ones. Most of the private colleges are self-financing and do not get any aid from the government. They build up infrastructure, pay salaries to the staff and carry out running expenditure from within the fee they collected from the students. Any shortfall in students' admission will result in less revenue and would make a college unsustainable.

In the last five years, some of the private engineering colleges have already been closed down due to less number of admissions each year whereas others are fighting for their survival. As an example, University of Jammu (India) has four private engineering colleges affiliated to it with sanctioned intake of 1,233 students in open merit category. During the current year 2019-20, 69% of seats have remained vacant due to non-availability of students as is clear in Table III [21]. If this trend continues, then at least two of the four colleges will close down, may be, in a couple of years. Therefore, it is utmost important to take preventive measures to avert this situation.

Based on the interaction with the faculty of universities and the colleges, following strategy is recommended to be

TABLE- III: STUDENTS ADMITTED IN PRIVATE ENGINEERING COLLEGES UNDER UNIVERSITY OF JAMMU DURING THE YEAR 2019-20

S.No.	**Name of college ***	**Sanctioned Intake, Open Merit**	**Number of Students who took Admission**	**Shortfall / Percentage Shortfall**
1	Engg. College 1	285	31	254 / 89%
2	Engg. College 2	150	33	117 / 78%
3	Engg. College 3	399	108	291 / 73%
4	Engg. College 4	399	207	192 / 48%
	Total	1,233	379	854 / 69%

*Note: Names of colleges have been hidden as desired by the management of colleges

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adopted by them:

- Conduct outreach programme to schools to motivate students for opting for science subjects.
- Invite students of neighboring schools for visit to their laboratories, show them the latest technological items which they are using at home or seeing in the environment and link these with science subjects. Also show them the projects being handled by them.
- Programs initiated by government and other national organizations which are initiated specifically to generate interest among school children must be implemented. One of such programs is INSPIRE (Innovation in Science Pursuit for Inspired Research) initiated by department of Science and Technology, Govt. of India [22]. Its aim is to attract talent to study science at early age. Another programme is VVM (Vidyarthi Vigyan Manthan) jointly organized by Vijnana Bharati, Vigyan Prasar and NCERT which aims to popularize science among students of 6^{th} to 11sth standard [23].
- Train a couple of faculty in each college to act as counselors and motivators for school children.

D. Role of State Education Boards and Schools

Main stake holders at the center stage of this research study are the school children. They are taught by the school teachers and follow the syllabus, and norms set by the regulatory authorities. In India, these are State Education Boards which regulate the functioning of the schools, lay down policy and ensure their implementation within the jurisdiction of their own state. They prescribe the syllabi, evaluation techniques and schedules for each class. They also organize training for the teachers periodically so that they remain in touch with the latest pedagogical aspects of teaching.

Children have great inherent qualities of inquisitiveness and creativity. These qualities must not be allowed to be died down as students move from class 1 to higher classes. These qualities must be given boost and curricula be designed accordingly. All the teachers of the schools must be trained for that aspect. Teaching based on Blooms Taxonomy is recommended to be adhered to [24]. Teaching and evaluation must be done to develop all the six cognitive domains of a student. The six cognitive levels are:

- Level 1 – Remembering
- Level 2 – Understanding
- Level 3 – Applying
- Level 4 – Analyzing
- Level 5 – Evaluating
- Level 6 – Creating

Once a student is taught in above method, he/she will naturally become interested in logical thinking and become more inquisitive to learn about the universe and newer technologies. Automatically one will become interested in science subjects. Other measures which are recommended for State Education Boards and schools are as under:

- Implement programs of VVM.
- Establish Atal Tinkering Labs and encourage maximum student to participate in these. Sufficient financial funds have been earmarked for the schools by the central government [25].
- Stress on active learning where in students' perspective must be seen so that he/she remains interested in studies [26].
- In countries like India where there are a number of national languages, all the students may not be very proficient in the English language at the school level. The teaching technique has to be different to keep the interest alive.
- Science is the study of everyday life. To promote its profile, teachers should come together starting from school level, and work towards investigating, promoting and displaying the potential of young talent, which will naturally inspire young people to take it up as a career later on.
- Teaching of science subjects must be linked to real time objects and activities.
- More stress on outdoor activities
- Organize field visits from class 1 onwards. At primary level, students can be taken to grocery shop, vegetable shops, post offices, gardens, zoos, to hospitals, firestations etc. and correlate the theory subjects of mathematics and general science with the processes they see during the visits.
- At secondary level, students should be taken to the laboratories of good engineering colleges, polytechnics, industrial training institutes, factories etc. to generate their interest in science and engineering subjects.

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- Have more laboratories in the schools to give students sufficient hands-on experience.
- Like in case of doctors and nursing staff, the teachers of schools should also be registered for teaching. Their license for teaching should be for 5 years or so after which it may be reviewed by the regulatory body.
- Condition for renewal of license should be completion of at least 20-30 hours of refresher course every year or 150 hours in five years as is the case of nurses prescribe by Indian Nursing Council in India.

VII. CONCLUSION

Engineering education industry is at the cross roads in many countries. Main reason as established is the lack of interest of students in science subjects in their early school days because of which they become ineligible for taking admission in engineering stream once they reach the college. If a country is devoid of science literate students and there are less engineers, then the country suffers in technology and has to depend upon other countries for all the latest technology-driven household goods. To overcome this problem, suitable strategies, suggested in this paper, are recommended to be adopted at various levels from government to school level to meet the challenge.

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