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Strategies for Enhancing Student Performance: A Comprehensive Analysis of Quality Improvement in Engineering Education in India

Shinde Goba[1], Santosh Sancheti[2*], Kainjan Sanghavi[3], Mahesh Sanghavi[4] Deepak Sancheti [5]

[1,5] Department of Mechanical Engineering SNJB's Shri.H.H.J.B.Polytechnic, Chandwad, Dist Nashik (MS), India

[2*] Department of Mechanical Engineering SNJB's Late Sau K. B. Jain College of Engineering Chandwad, Dist Nashik (MS), India

[3,4] Department of Computer Engineering SNJB's Late Sau K. B. Jain College of Engineering Chandwad, Dist Nashik (MS), India

[1]goba.shinde453@gmail.com [2*]santusancheti@gmail.com [3]kainjan@gmail.com
[4]sanghavi.mahesh@gmail.com [4]deeps.sancheti@gmail.com

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Abstract

This research paper delves into the imperative of quality improvement in engineering education in India, a critical factor for aligning the country's technical institutes with global educational standards and the demands of a knowledge-based economy. The study is motivated by the dual challenges of rapidly evolving technological landscapes and the critical deficiencies in current educational practices, as highlighted by the National Board of Accreditation (NBA). This paper explores the multifaceted dimensions of quality in engineering education, including curriculum development, teaching methodologies, faculty qualifications, and infrastructure through a comprehensive literature review, faculty and student interviews, and qualitative analysis. It underscores the significance of the Faculty Development Programme (FDP) initiated by the NBA and the Technical Education Quality Improvement Programme (TEQIP) supported by the Ministry of Human Resource Development (MHRD) and the World Bank. The research objectives focus on identifying obstacles to quality education, understanding stakeholder expectations, and recommending strategies for continuous quality improvement. The methodology prioritizes findings through a Pareto chart, highlighting areas requiring urgent attention. The study reveals a strong need to align educational objectives with student needs, enhance faculty qualifications, and integrate practical knowledge and modern technologies into the curriculum. Recommendations include adopting research-based teaching methodologies, emphasizing NBA quality parameters, and formulating effective policies and strategies for dynamic curriculum development. The findings and recommendations contribute to the ongoing discourse on enhancing the quality of engineering education in India, aiming to produce globally competent engineers capable of contributing to societal and technological advancements.

Keywords— Quality Improvement, Engineering Education

Introduction

The quality of engineering education in India has reached a critical juncture, necessitating an immediate and strategic overhaul to align with global standards and the evolving demands of a knowledge-based economy. This imperative is underscored by the rapid technological advancements and the need for engineering graduates who are proficient in their technical domains and adaptable, innovative, and capable of addressing complex global challenges. It has been acknowledged that the program can facilitate coaching the college on innovative teaching methodologies, the latest trends, and advances in various technologies, as well as improve the standard of teaching and research. So, a scientific and trendy approach to education and sharing quality thoughts are solicited to remodel tutorial education in India. However, the standard improvement and quality assurance measures in technical institutes need commitment and involvement from all the scholars and members of the institute. The institute's associate degree institute, as an entity, should have a clear focus

on realizing the country's vision by achieving the objective of changing into an internationally recognized technical institute that provides quality education.[1]

In 2009, the NBA started implementing an ingenious program known as the Faculties Development Programme (FDP) across the country. This program relies on the quiet success of the Technical Education Quality Improvement Programme (TEQIP). The World Health Organization was established by the Ministry of Human Resource and Development (MHRD) with the help of the Global Bank. As expressed within the program details, FDP aims to train and remodel the personnel and students of engineering and technology institutes through constant quality improvement and quality assurance initiatives.

This analysis has been motivated by the recent spurt in educational activities and, therefore, the low pass-out rate of engineering students. As per a recent report by the National Board of Accreditation (NBA), various deficiencies are reported within the technical institutions of India. This report calls for a fast and high-level investigation of quality improvement in India.

The approach of the Indian economy as knowledge-based is currently delivering new challenges to the standard of engineering education. To fulfill this demand, it is imperative to supply globally acceptable quality education. It has been suggested within the literature that for a developing country like India, the main focus ought to be enhancing the standard of the existing system as critical improvement and development. [2] [3]

A. Background

As the global economy rapidly changes into a knowledge-based economy, the quality of higher education has become extremely important. This is especially true in technical education, where rapid technological innovations and inventions are constantly occurring. Such quality technological advancements in India have significantly impacted today's industry, whether in software development or various engineering fields such as mechanical, electrical electronics, communication, or even civil engineering. Unfortunately, the quality of engineering education in India has been criticized for many years.[4] [5]

The main areas of concern are

- Outdated curricula,
- Overcrowded classrooms,
- Lack of suitable infrastructure facilities,
- Predominantly lecture-based instructions,
- Heavy emphasis on examinations,
- Inadequate hands-on laboratory work,

There is a need for qualified faculty members capable of teaching and conducting research in a modern technological environment.

As a result, it is essential to address the quality of engineering education in India and its response to a globalized and rapidly technological world today. This study seeks to discover the most critical obstacles to the quality of teaching and learning in higher education in a technological and rapidly changing learning environment and to provide research evidence for improving the quality of engineering education in India. [6] [7].

B. Research Objective

The primary research objective of this paper is to thoroughly examine the necessity for continuous quality improvement in engineering education within the context of India. This includes understanding the multifaceted issues hindering quality improvement in technical education and offering actionable strategies to overcome these challenges. The study aims to:

1. **Assess the Current State of Engineering Education in India:** Evaluate the existing educational practices, infrastructure, curriculum design, and faculty capabilities to identify gaps between current standards and global best practices.
2. **Understand the Dynamics of Curriculum Development:** Investigate how a sustainable, dynamic, and up-to-date curriculum can be developed and maintained to ensure that engineering education in India keeps pace with the latest technological advancements and industry demands.
3. **Highlight the Role of Continuous Improvement Processes:** Explore the structures and organizational strategies necessary for establishing a culture of continuous quality improvement in technical education, including adopting systemic educational innovations.
4. **Analyze the Impact of Assessment Systems on Learning Environments:** Consider alternative assessment strategies to annual examinations, such as periodic evaluations, to foster a learner-centered environment and encourage a reflective culture on educational outcomes and program effectiveness.
5. **Promote a Comprehensive Understanding of Quality in Education:** Cultivate a broad awareness among educators, administrators, and students about the importance of quality in education and their respective roles in maintaining and enhancing these standards.

This paper highlights the importance of quality improvement in engineering education in India and provides practical recommendations for achieving this goal. Students need confidence in the values of their qualifications in order to begin their careers in the best possible positions. As a knowledge-rich and research-based domain, it is a challenge for teachers

to keep the materials current and include the most recent practices and technologies in the curriculum.[8] [9] Therefore, a sustainable curriculum is an essential factor towards quality curricula in engineering education. A continuous improvement process requires structure and organization, which defines the aims of a permanent and systemic educational innovation. Nevertheless, what sort of curriculum development will lead to effective professional practice? The earlier a student's misconceptions are identified and corrected, the quicker the student can absorb new concepts. Learners approach learning in different ways and with different preferences. The teacher must be flexible and address learners' needs, helping the students understand the learning process. Ränk and Walter suggest that annual assessments do not help to make an environment learner-centered [10] [6]. If the university were to adopt a periodical system - every five years - the department and the program should have sufficient new things to say to that review and sufficient new data and measures to present the learning outcomes. At that point, one would develop a culture of reflection on the program, its outcomes, and its components. Helping people understand "quality" is a crucial step towards quality itself. All the relevant staff should be involved in the decision-making of the day-to-day maintenance of quality, and all staff should be aware of their responsibility for and role in maintaining quality standards. Quality assurance and quality improvement have to be managed and implemented systematically. [11] [12]

C. Methodology

A Pareto chart was used to prioritize findings and determine which areas should be given priority when coming up with the recommendations. A *Pareto chart* is a tool that helps to choose the most significant problem at any particular time by recognizing the most frequent categories that appear in a problem array. The interviews were recorded, and written notes were taken for the faculty and student interviews. The notes and recorded interviews were then reviewed several times to generate themes that were showing up consistently throughout the interviews. It is from these themes that a set of recommendations were formulated. [13]

The interview methodology was preferred mainly because it allows for in-depth information collection. Surveys or questionnaires might not delve into profound issues that may be raised during an interview. Also, with an interview, there is an opportunity to give and seek clarification on the questions. The interviews were semi-structured, meaning that the questions were open-ended, and the interviewees were allowed to give detailed explanations on the necessary points. This is essential in ensuring that significant but unforeseen information is captured.[14] [15] [16]

After the literature review, interviews were conducted among faculty and students to better understand the current circumstances and the underlying challenges that prevent quality education. The faculty interviews aimed to understand how the curriculum is developed, what standards and parameters are given priority, and what challenges the interviewees face in ensuring quality is achieved. On the other hand, the student interviews focused on understanding student expectations, their level of satisfaction, and where they think improvements are necessary in the curriculum and teaching methods.

The study's primary objective was to develop a set of recommendations for enhancing education quality in engineering institutions in India. To achieve this objective, a literature review was conducted. The literature review aimed to understand how quality in education is defined, what the principles of quality education are, and what strategies are used to achieve quality education.

I. 2. Importance of Quality in Engineering Education

Quality in education is a crucial requirement for acquiring skills, knowledge, and values. This is also the case in the education of future engineers. Whether in the profession, consultancy, industry, or R&D, engineers will need to keep abreast of rapidly changing knowledge and practices. This will require well-cultivated and deep-rooted scientific knowledge, problem-solving skills, social understanding, and personal values.[17] The main reason behind this is that the products and services that engineers will develop and introduce, or the professional advice they will provide, will directly impact society and the quality of life of the people. Moreover, in an increasingly competitive global market, quality is the watchword for survival and the key competitive differentiator and driving force. With this necessity, it is very heartening to note that higher education is starting to undergo a culture change to place quality at the heart of its planning. Notably, in the case of engineering education in India, there has been a complete policy change in the last decade. The prime focus of this education change and development pertains to establishing the National Board of Accreditation (NBA). This body has the statutory authority for quality assurance and accreditation of technical education disciplines. The NBA's primary goal is to promote and develop quality engineering education in India systematically and effectively. To achieve this goal, all parts of the education system should be involved in continuous and self-motivated quality improvement. [5] [18].

There are two main strategies for achieving and maintaining quality, namely

1. Improving the qualification of the teachers
2. Enhancing the quality of teaching and learning.

These involve working with the staff and students and piloting new methods and activities in curriculum development and student performance. The result will be delivering the students up-to-date, systematic, dynamic, and diversified learning programs. In this context, the program that develops and promotes quality in engineering education plays a critical role. One key focus of this program is bringing the learning and teaching experiences and views of staff and students into the mainstream of consideration and reflection. In other words, students' particular needs and wishes and how they learn and perceive. This emphasis is most visible in the quality manual developed by the program. The quality manual is a comprehensive working document with detailed guidelines and criteria for assisting departments and program teams in

conducting internal self-assessment exercises, which aim at recognizing those areas that need further development and those where success has been achieved. It is always expected that the outcome of those exercises will benefit both the staff and students and will form the basis of fruitful discussions about future developmental planning.[19] [20] This kind of approach is essential and crucial. In the final analysis of any educational endeavour, the views and experiences of the students are crucial for bearing testimony to fulfilment and achieving the desired aim of providing quality education. Last but not least, another notable aspect of the program's strategy in promoting quality in engineering education is the focus on developing and maintaining a supportive and technology-endorsed learning environment and resources. Such an environment can be both physical and virtual. The rationale for this is to encourage and facilitate both staff and students to engage with a broader range of learning modes and methods and to take precise and innovative solutions in expanding and utilizing the potential of the latest technology in reaching the desired aim of the program. Such a move is considered vital for further improvement in the practice and delivery of the program to meet the expectations and standards. It also aligns with the vision to provide a worldwide quality program in engineering education. [21] [22]

A. Significance of NBA Quality Parameters

Despite a general understanding of the vital significance of quality improvement in higher engineering education, this education is insufficiently studied. The National Board of Accreditation (NBA) recently released an updated version of the program outcome and program-specific outcome.[23] The students in the Engineering program are expected to work as experts in research and development. With the help of the latest technologies in the industry, they are expected to gain experience in the latest scientific research to train them to be ready to embrace emerging and interdisciplinary research. "At least 4 out of 5" for every parameter evaluates students' performance in terms of the extent to which students can achieve the specific outcome. Also, the minimum acceptable value of "at least 2.5 out of 5" for every parameter evaluates students' performance in terms of the extent to which students can achieve specific outcomes. The student in this program will get solid engineering knowledge and experience, enabling the student to handle complex problems in inter- and multidisciplinary research and practical work. The student will especially be exposed to the latest developments in engineering studies and many others. Based on the program-specific outcome, the dwell time and the daily operation are significantly reduced by utilizing the results from various analysis software. This also implies time efficiency and the practical application of automated results in the work routine.

Log Information from five sources, mainly from the students and their internship supervisors, lecturers, and alums, were analyzed. Every source is evaluated under the eight parameters. This is taken as satisfactory, and it especially demonstrates the acceptance and belief in the quality of the results from the powerful analysis software. It can be seen that the parameter named "satisfactory completion of specified project milestones" for the program outcome gives the highest rating. The rating is around 4.5 to 4.75 out of 5, and this parameter, which evaluates the students' knowledge mastering and practical competency, shows the highest score of "at least 4 out of 5" among all the program outcomes. [24]

B. Role of Student Needs Alignment

"Autonomous scientific and technical degree awarding institutions, such as those providing engineering degrees, are expected to fulfill the student's aspirations with a balanced emphasis on teaching and research. Multiple accrediting organizations globally have stressed the importance of linking student needs to academic programs to ensure continuous quality improvement in higher education. IIE, the accrediting body for undergraduate programs in the USA, mandates a periodic evaluation and revision to include measures of student performance, the satisfaction of constituencies, faculty development, and practical uses of assessment results to establish a comprehensive program of quality improvement. Similarly, in India, the National Board of Accreditation (NBA) has been conducting quality assessments and accreditation of engineering programs based on the prescribed norms and criteria.[25] [26]. NBA emphasizes that the prime focus of the accreditation process should be to ensure that the program's outcomes emanate from its mission and goals. However, the need for integrating student-centered measures, another prescribed parameter for continuous quality improvement, has been highlighted in recent literature. In all the research and practices of quality assessment in engineering education in India, faculty are considered the primary stakeholders in the curriculum development and review process. The customary practice is to analyze and align the program's constituent elements, such as course learning objectives, classroom teaching methodologies, and assessment strategies, mainly from the perspective of the delivery by the teaching faculty. It has been observed that in most faculty-led curriculum improvement initiatives, a natural tendency of following a process of assessment and alignment centered on the faculty is being adopted, often neglecting the potential alignment based on the needs of the student community [27] [28]. The need for a close integration between faculty and student measures has also been underscored to cultivate shared awareness about the importance of and commitment to students' attainment among the faculty. A systematic approach to using the student's performance data for program evaluation and improvement is laid out based on the Plan-Do-Check-Act (PDCA) model, as the literature recommends.

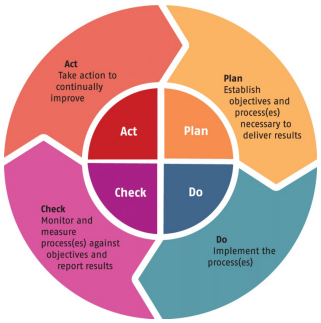

Fig 1: PDCA Cycle

The PDCA model is a well-recognized and widely accepted framework for continuous quality improvement. This is where there is a complete integration of the quality improvement process in a curriculum review endeavor, primarily led by the faculty, pursuant to the marching order of NBA—apperception from feedback and the direct interaction of students in the quality improvement loop has been proposed." [29] [30] [31]

II. Findings and Analysis

The findings from student interviews revealed that the emphasis on practical knowledge and personalized attention are the foremost priorities according to the data collected. Many students highlighted issues with large class sizes and insufficient laboratory facilities as prevalent challenges in many public universities. Among the topics discussed, integrating practical knowledge and ensuring personal attention to students emerged as the most frequently mentioned, capturing 26.9% of the discussions, followed by calls for regular updates to course content, which accounted for 19.2%. The concern over large class sizes was raised in 17.8% of the feedback, with some interviews indicating that classes with 60 to 70 students are a common scenario.

Furthermore, a substantial majority of students, 90.7%, concurred that adhering to NBA (National Board of Accreditation) quality parameters—such as having permanent faculty, professors, and industry-experienced lecturers—is critical for enhancing education quality. Close behind, 84.3% of students highlighted the importance of aligning student needs with educational objectives, and 83.6% advocated a stronger focus on achieving outcomes that align with educational visions.

The analysis also revealed a strong positive correlation between the emphasis on permanent and experienced faculty and the overall importance attributed to student considerations. A moderate positive correlation was observed when aligning student needs with educational objectives and emphasizing outcomes, indicating that these aspects are interconnected. Specifically, the relationship between the quality of faculty and the attention to student needs demonstrated a notable correlation, underlining the significance of these factors in educational quality improvement strategies.

This analysis underscores the necessity of adopting a holistic approach that considers the perspectives of management, faculty, and students in developing effective quality enhancement strategies. Such an approach is essential for meeting the specific requirements set by international accrediting bodies and the broader objectives aimed at enriching academic learning experiences, as envisioned by educators and learners alike.[32]

TABLE I

Analysis of Educational Quality Factors and Their Frequency

#	Theme	Frequency (%)	Notes
1	Practical knowledge and personal attention	26.9	Highest frequency among codes.
2	Frequent revision of course contents	19.2	
3	Large class size	17.8	40-50 students in one class is common.
4	NBA quality parameters importance	90.7	Permanent teachers, professors, industry-experienced lecturers.
5	Student needs alignment with educational objectives	84.3	
6	Emphasis on student outcomes	83.6	Aligning with the vision for learning.
7	Correlation between permanent teachers and mutual importance	Strong, positive	Important aspect in quality development.

8	Correlation for student needs alignment and outcomes measurement	Moderate, positive	Found in every group for effective strategy.

C. Student Interviews

It was expected that students, who are at the heart of the educational process, would express their needs to the education system. During the qualitative part of the study, the research team interviewed students from different years and divisions of the same engineering faculty. The faculty has recommended some students as motivated and interested in the department's future. Each interview lasted approximately 40-50 minutes, and the results were recorded and then transcribed. The focus of the interviews was to reveal how the students understand the quality and its main parameters in the context of engineering education.

The questions asked to the students during the interviews, in sequential order, are as follows:

- What is your understanding of the term "quality"?
- What do you consider "quality education", and what are the main characteristics of this type of education?
- Can you compare the quality of education in your homeland with that in foreign countries?
- What are the positive and negative aspects of the current state of education quality in the engineering faculty?

In the interviews, categories of grounded theory and its methodology were applied. *Grounded theory* is a well-known research method that helps develop a theory that is "grounded" in the views, experiences, meanings, and insight of the research subject, not the preconceived hypothesis. The main idea of grounded theory is to create something that can help researchers explain and understand the main actions and the main processes of a particular educational event [33].

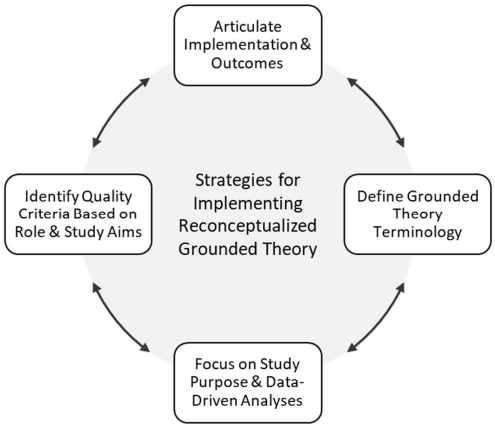

Fig 2: Perspectives for Implementing Grounded Theory - Studies in Engineering Education

During the interview, open and axial coding was used. Open coding means breaking down, examining, comparing, conceptualizing, and categorizing data and "properties" and "dimensions" therein. In axial coding, the focus is on the conditions that could influence or have a casual relationship to the phenomenon. As a result of these codes, the various categories have been defined by researchers, and after that, other categories and the core category have appeared in the process of selective coding. The interviews were conducted in English and held in a particular meeting room at the college campus, where there was no lecturer or professor from the faculty. All the students were informed about the study and agreed to participate in the research process. The students were provided with the information sheets and consent forms to sign, thus confirming that they clearly understood the study's objectives, the assessment of the role they would play, and the future of the results. The interview question was based on below 12 Quality parameters

- **QP1: Real-life Teaching -** Incorporating practical, real-world scenarios into the curriculum to enhance learning effectiveness.
- **QP2: Software and IT Infrastructure** - The availability and quality of software and IT resources for students.
- **QP3: Laboratory Facilities -** The adequacy and modernity of lab facilities for practical experiments.
- **QP4: Class Size -** Optimal student-to-teacher ratios that facilitate personalized attention and better learning experiences.
- **QP5: Course Content Relevance -** The degree to which course content is up-to-date and relevant to current industry practices.
- **QP6: Faculty Expertise -** The qualifications and industry experience of the faculty members.
- **QP7: Student Support Services -** Availability and quality of support services for students (counseling, career guidance, etc.).
- **QP8: Internship Opportunities -** Availability and quality of internship programs for practical experience.
- **QP9: Research Opportunities -** Opportunities for students to engage in research projects and initiatives.

- **QP10: Industry Collaboration -** The extent and quality of the university's collaboration with industry partners.
- **QP11: International Exposure -** Opportunities for students to gain international experience (e.g., exchange programs).
- **QP12: Environmental Sustainability -** Incorporation of sustainability practices and teachings within the campus and curriculum.

It should also be mentioned that no personal or sensitive questions about a student's life or personal experience have been asked during the interview. All of the results have been anonymized as well. Thus, no references to the actual names or places are included in the text. All possible ethical issues have been considered, and as a result, a detailed plan of the researcher's actions has been created. All interviews and interviewers have been registered and received from the unique educational department of the university registered with the Data Protection Act 1998. All of the research actions have been carried out in accordance with that legislation.

D. Importance Rating Collection

The results of the ratings and feedback collected towards each of the twelve quality parameters are presented in this section. Each group member saw the average rating for every quality parameter from both morning and afternoon sessions and their rating. The group members are required to rate the importance of each quality parameter relative to the other quality parameters. A ranking of 1 would indicate that the quality parameter is most important, while a ranking of 12 would indicate that the quality parameter is least important. The data is then collected for 240 students and analyzed statistically to provide a quantitative understanding of the weight of each parameter. The mathematical process involved in the analysis is a pairwise t-test. It has recognized the importance of each quality parameter from the perspective of engineering students. For instance, in Figure 3, the software and IT infrastructure have been rated the highest in contrast to the other quality parameters. The highest average rating has been found in the 'Real life teaching' parameter. [34,35]

The significant standard deviation implies that most of the ratings are concentrated at the top of the scale. However, the position of the mean rating bar is far from the upper limit (7), indicating that a small number of people rated the parameter as the maximum. Another noticeable thing is that the average rating difference between each quality parameter could be more apparent. There are four parameters with an average rating above 6; six have ratings falling between 4 and 6, and two are below 4. Cross-checked the standard deviation calculated from the rating data and the standard deviation illustrated in the bar chart. They are the same, and the bar chart correctly represents the data. The finding gives an apparent understanding of the absolute need for this parameter. It has also attracted interest, as this parameter has obtained the highest average rating. The result also shows a significant standard deviation in the data. This can be another indicator that the parameter has a different perception from each individual. However, the parameter is rarely described by other scholarly work in quality parameter research. This can be a new research dimension in the future.

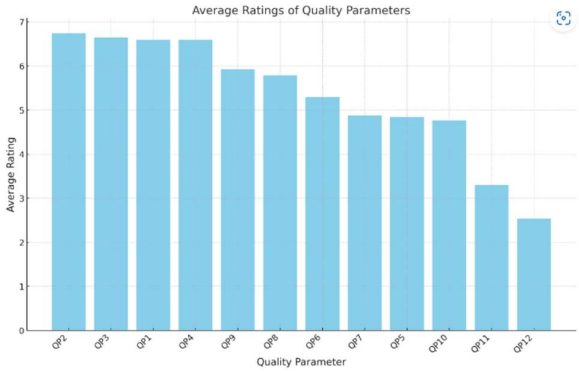

Fig 3: Average rating of Quality Parameters

TABLE IIIII

TABLE 2: QUALITY PARAMETERS AND IMPORTANCE RATING

Quality Parameter	Average Rating	Standard Deviation	Importance Ranking
Software and IT Infrastructure (QP2)	6.74	1.89	1
Laboratory Facilities (QP3)	6.64	0.61	2
Real-life Teaching (QP1)	6.59	1.35	3
Class Size (QP4)	6.59	0.63	4
Research Opportunities (QP9)	5.93	1.97	5
Internship Opportunities (QP8)	5.78	1.81	6

Faculty Expertise (QP6)	5.29	1.75	7
Student Support Services (QP7)	4.88	1.67	8
Course Content Relevance (QP5)	4.85	0.53	9
Industry Collaboration (QP10)	4.77	1.70	10
International Exposure (QP11)	3.30	1.19	11
Environmental Sustainability (QP12)	2.53	1.67	12

E. Correlation Establishment

Spearman's rank correlation test is conducted through statistical software to correlate the opinions of various stakeholders and emphasize different parameters in the rating scale.

Spearman's rank correlation coefficient, denoted as ρ (rho) or sometimes as *rs* , is a nonparametric measure of rank correlation that assesses how well the relationship between two variables can be described using a monotonic function. The formula for calculating Spearman's rank correlation coefficient is:

$$\rho = 1 - \frac{6\sum di^2}{n(n^2-1)}$$

Where,

ρ is Spearman's rank correlation coefficient,

di is the difference between the ranks of corresponding valuesXi and Yi

n is the number of observations.

The approach takes each vital parameter as a separate variable, and stakeholders' rankings of the parameters are taken as an instance of the data process. With this approach, the statistical software will give the correlation coefficient between -1 and +1. A high positive correlation signifies that stakeholder who ranked one of the essential parameters highly ranked the others high, and stakeholders who ranked that specific parameter low also ranked the others low. Conversely, a high negative correlation signifies that stakeholders who ranked a specific parameter highly ranked the others that are highly correlated low and vice versa. The result proves that the correlation among different data observations is relatively low. The correlation coefficient value of the 16 pairs of the ranking and the variables ranges from -0.2 to +0.2. Based on the standard guideline for interpreting the correlation coefficient, it is found that a majority of the values, in this case, may be interpreted as 'very weak' or 'negligible.' For example, the coefficients of the first 15 data pairs are all in the range of +0.04 to +0.15. These correlation coefficients show a lack of correlation among the data. The result shows that the stakeholders have varying options and opinions over different parameters in the rating scales. Only a few pairs of parameters are found to have relatively higher correlation compared with other pairs of data. For the 3rd and 4th pairs of data (i.e., coefficient = +0.20) and the 11th and 13th pairs of data (i.e., coefficient = +0.17), these correlation coefficients show a small but positive correlation. The two parameters have some degree of influence on the rating scale. This result provides a valid background for facilitating the refining of the final set of quality parameters in the rating scales.

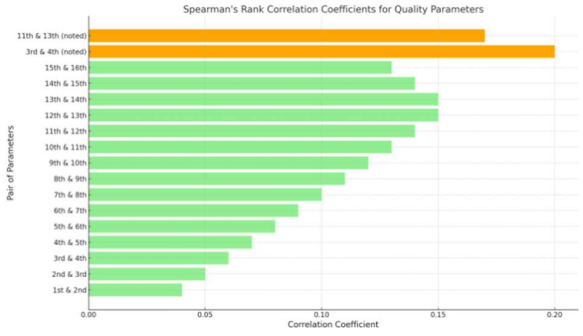

Figure 4: Spearman's Rank Correlation Coefficients for Quality Parameters

III. Recommendations for Enhancing Education Quality

One way that the teaching of research-based argument can be integrated into engineering courses is to develop student skills in gathering and evaluating evidence. As the capacity for developing, storing, and exchanging information continues to grow, an essential goal for engineering students is to become educated citizens, citizens who are willing and able to engage with the social and political issues that increasingly confront technological societies. Developing the ability to articulate and defend a position based on evidence is crucial in this process. For students to learn to write strong arguments, alternative strategies, and teaching methods must be considered. One possibility would be to adapt some writing methods

across the curriculum to the engineering classroom. This approach may have the advantage of introducing students to the recursive and social dimensions of writing. Such recursive writing implies that given good feedback and critical reflection on their and others' work, students can improve substantially over time. The social dimension of writing refers to the knowledge that specific conventions and expectations govern a particular discourse community. In embracing this knowledge, the writer becomes aware not only of the power of language and the existence of different opinions but also of the writer's responsibility to the intended audience. Also, the open-ended approach of writing to learn might be a beneficial way for engineering students to tap into their creativity and critical thinking; it lays the possible groundwork for bringing in research-based arguments early in the course work. [36] However, such integration will require that engineering faculty take a more overt and reflective approach to teaching writing. Writers must describe why and how they use specific sources, a technique often called 'mapping the use of sources'. The exploration of different citation strategies helps writers explore the 'rhetorical uses of citation', shifting the focus from simply objective or neutral reporting of data to the recognition that the research world is a conversation, a debate in which multiple voices interact. This extension of the writing-across-the-curriculum notions to the teaching of research-based argument further presents a possibility of inclusively collaborating with students on fundamental research problems in which they might utilize argumentation in proposal writing. This opportunity to engage in research practices is a strong pull for engineering faculty and students; it brings proposal writing to the broader frame of writing and rhetoric as a tool for persuasion [37]. The teacher's primary role is to provide the necessary background, development, and context for authentic student engagement with the argument. By recognizing the need for real-world application of literacy and communication skills, faculty can contribute meaningfully to developing students as capable and confident knowledge-makers.

A. Focus on NBA Quality Parameters

The National Board of Accreditation (NBA), the premier accrediting body in India for engineering programs, has specified ten criteria for program accreditation, each consisting of very specific sub-criteria. Over the past ten years, it has been observed that most of the engineering institutes in India have made a "self-assessment report (SAR)" for accreditation, focusing exclusively on the documentation of facilities available in their institutes and the expertise of the teaching faculties. The fact that documentation work gets primary importance in the accreditation process has made the institutes centred on the short-term materialization of facilities rather than the overall quality improvement of the faculty members or the technical staff. In effect, most of the academic decisions in these institutes have been made on establishing test facilities rather than implementing effective curricula, faculty development programs, or research and development. Hardcore academic practices like maintaining the course file, preparing the lecture schedule in the very beginning, updating the course plan after the academic delivery, arranging tutorials regularly, or ensuring continuous improvement of the course instructions are never valued until they are correctly linked with the documentation procedures outlined by NBA and subsequent accreditation process. As a result, the measures taken to improve overall educational experience and expertise have very rarely appealed to most of the faculty members, and often, they need to be prepared to undertake extensive documentation and preparation for the accreditation process. Also, the need for proper coordination and haphazard time schedules among the different faculty members and the staff, as well as different documentation approaches and lengths in the same institutes, have often minimized the outcome of the accreditation exercise. Even in the previous years, when the NBA criteria required the institutes to accrue appropriate input from the industries and balanced coverage on the course designed, the concentration was given on the documentation of the new facilities requested rather than focusing on the real advantages and disadvantages of the facilities and establishing ways to improve the overall course contents, instructions, and experiments, and hence provide more effective educational inputs.

B. Prioritizing Student Performance

The stage of prioritizing student performance is challenging due to diverse expectations and limits in fulfilling those expectations. In the first step, a periodic activity timetable will be prepared so that the time allotted for each educational, co-curricular, and extra-curricular activity will be spent usefully and interestingly without any monotony. During the study hours, the teachers should supervise and teach suitably by giving care and attention and helping the students, and they should not do other work. This system practice will increase the teacher's interaction with the students. Of course, teachers should be encouraged and motivated to bring out their innovative teaching practices by providing them with leadership opportunities in daily college activities. Lastly, the parents and the opinion leaders available in the society should be motivated and convinced about the good impacts of keeping the children at home with greater attention and caring by the domestic environment than mingling the children in our discussion. The paper has critically analyzed the data collected. It has employed several methods, using software programs to analyze the first and second drafts and institutional databases to obtain the average student's performance and the percentage pass for a four-year student's performance. The paper has shown the success of each method in the analysis. The importance of student performance is measured in several ways, such as stratified by different measures, etc. Such a method can deepen the understanding of students' learning studies in many institutions and will be used and expanded more in the future. Well, comparing the student's performance at the end of the duration with the GPA, which is cumulative.

C. Formulating Effective Policies and Strategies

Formulating effective policies and strategies is a critical element of education. The analysis shows that there is a need to align the current education practices with student requirements. First, there is a need to make policies and strategies

that are more adaptive and dynamic. Usually, policies that are more static and need to keep pace with the changes in time and requirements are in place. Such policies will always have a limited impact. However, if the policies are made in such a way that they should be more adaptive and can change with time, these policies will have a more far-reaching impact. One of the essential considerations that need to be kept in mind while formulating any policy or strategy for education is that a policy should not only meet the current requirements or address the current issues, but it should also give proper consideration to the future requirements. Because the policies will take time to unfold on the ground, once policies start impacting, there may be a change in the original situation. Then, that policy will have to cope with that changed scenario. There is a requirement to conduct detailed education research and literature support to have a research-based policy. However, most of the policies and strategies are made experimentally. First, a policy is launched as a pilot project, then tested on the ground, and then these policies are continued, extended, or washed out. The student preference for quality aspects of education discloses that students' opinions and quality assessment parameters could be fused to measure the quality of education in a better way. The policy should have such a mechanism through which the impact and effectiveness of the policy could be measured. The policy and strategy-making process should have a continuous analysis, planning, action, and feedback cycle. Such continuous assessments of the impacts of policies will ensure that the policies have an adaptive capacity and a better ability to cope with the changes over time.

IV. CONCLUSIONS

The research presented in this paper comprehensively addresses the critical need for quality improvement in engineering education in India. It highlights the challenges and deficiencies currently plaguing the system, from outdated curricula to insufficient infrastructure and the need for faculty development. The study emphasizes the importance of aligning educational practices with global standards and the evolving demands of a knowledge-based economy. Through detailed analysis and stakeholder feedback, the paper identifies critical areas for improvement, including curriculum relevance, teaching methodologies, faculty qualification, and infrastructure enhancement.

The recommendations offered, based on a systematic analysis of the collected data, propose a holistic approach to revamping the engineering education system in India. These include

- A focus on NBA quality parameters,
- Prioritizing student performance,
- The development of effective policies and strategies for continuous improvement.

Implementing these recommendations requires a concerted effort from all stakeholders, including educational institutions, accrediting bodies, the government, and industry partners.

Ultimately, this paper contributes valuable insights and practical recommendations to the discourse on improving engineering education in India. By adopting these recommendations, India can aspire to not only address the current gaps in its engineering education system but also position itself as a global leader in producing highly skilled, innovative, and socially responsible engineers. The journey towards quality improvement is complex and ongoing. However, with committed effort and strategic vision, it is possible to transform engineering education in India into a world-class system that meets the needs of the 21st century.

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