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Technology of engineering education: An Understanding of the present day processes, conditions and limitations in which learning and teaching take place

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ABSTRACT- Engineering as a profession in the truest of sense appears to be losing its shine today if one is to do a comparative analysis with what it was till a few decades back. What could be the possible reasons for the lackluster approach of today's generation to this branch of study or even as a career? This paper aims to probe into the possible gaps associated with the learning process from the perspective of the technology of engineering education. There is a major overhaul in the management, curriculum and learning styles of Engineering with time. There is an influx of changes seen in all sectors ranging from academia to research and industry. An effort is also made to plug the gaps after analysis of the gaps along with the forward path associated with implementation of the findings.

Keywords: Engineering, Learning gaps, Application, Research-based

Objective

Engineering, as a specialized branch of studies dates back to as early as the13th century and there are numerous contributions that are still appreciated today. Some of these include the pyramids and Pharos of Alexandria in ancient Egypt, the Colosseum of Rome, the Great wall of China, etc. However, now with so many engineering colleges blooming across the globe leading to the generation of engineering graduates every year, why is it that we fail to see a proportionate contribution in the development of engineering marvels? Is it something to do with the way the engineering is being taught or the manner in which today's engineering students are learning this science? These are some of the questions that shall be touched upon in this paper to undermine the Cognitive and metacognitive insights of the Engineering learning process.

Present Scenario of Engineering Education in India

Even though we have more than 4,000 engineering colleges in India offering degrees in more than 10different disciplines, there appears to be a skewed alignment between the engineering education process and the associated practice when it comes to implementation. Is this gap between the understanding of the engineering practice on the part of the engineering educators beyond the conventional design and the problem solving contained in the academics? Today a sizeable quantum of the engineering graduates think about alternative occupations after graduation. Even during the academic sessions within the campus, the students seem to get bored very soon there by skipping the theory classes. If we look into the Washington Accord (WA), there is evidence of many desirable attributes of engineering graduates that are yet to bead dressed in-to to by the Engineering institutes. This could be one of the impact factors because of which majority of today's employers are also not satisfied with the capabilities of the engineering graduates. Another important aspect supplementing this crisis is that engineering education appears to be losing ground on attracting talented students who really want to contribute to the process of societal development.

Views of today's generation

Various engineering programs are often reputed to be cumbersome and difficult because of which they get deprived of some good talent. For the students who get admitted into the engineering colleges, the prioritization process starts with making friends who can share all the happenings– both academic and co-curricular. Coming to academics, some of the students opine assignments to be at par with the viruses, where a single copy gets replicated within other students. Looking into today's knowledge accessibility scenario through the internet and devices like smartphones, tablets,

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etc. notes and reports are readily accessible. All it takes is to copy and paste which often trans forms the viva into a nightmare. So what is it that one is likely to miss if the offline physical classes are left unattended? For another section of the students, Engineering is just another regular degree to be secured as a part of the graduation programs.

The gaps in the prevailing engineering education process

Today's engineering students have ready access to journal articles, conference papers, technical reports, patents, standards, websites, trade publications, and dissertations over and above the normal content of the syllabus. Then there is availability of various search engines like Google, Chat GPT, etcon the click of a button. The question then is - How is this gap in the prevailing education process not getting plugged? The first gap appears to be in the form of the weight age that is given to the technical competencies vis-à-vis the professional competencies like communication skills, business skills, teamwork skills, creativity, lifelong learning skills, and problem solving skills which are nothing but the "real-world-skills". This leads to yet another question – Are today's engineering programs still based on an outdated image of engineering practice that is misaligned with reality? And last, but not the least, why is it that engineering students often seem to be uncertain about what engineering is all about and what engineers actually do or supposed to do, even by the time they graduate? The consequence of these uncertain facts about what engineering really involves and the gap of being ill-prepared are also resulting in some graduates abandoning the engineering profession at some point of their careers. T here is a need to impart a better degree of understanding of engineering practice to inform students' career choices and improve their preparedness to work in this field.

Findings from an observational analysis

An important factor towards enhancement of the learning process is identification of the learning gap. Any disparity between what an engineering student has actually mastered and what is expected at their particular grade level should be proactively identified and rectified. The prevalence of this learning gap could be on a particular topic or a particular subject or even more than what it meets the eye. Irrespective of the quantum of the gap, all educators should appreciate the fact that a student's education builds on previous concepts ask into building blocks and any lapse can weaken the foundation. After almost a decade long association with the education field, I tried to summarize the progressive findings from an observational analysis of the learning gaps. More emphasis of Research based teaching methods needs to be implemented. We need to empower students with the possibility to work on innovative projects and expose the publication of the results in various scientific venues. Some may argue this approach to be easier said than done primarily because certain concepts could be hard to quantify, e.g. how good the research project is. However, in the contextual learning stage, this can be over ruled seven within the research community it is often hard to access such a question. What is required here is a transition in the mind-set of the students towards an application based approach. Another challenge in this approach could be of how to transmit the uncertainty of scientific outcomes to students so that they do not get disheartened in case of inconclusive results. This is still arduous and there could be times when we just need to profoundly change the nature of teaching in engineering education and allow uncertainly to be part of the game after taking into consideration the time limits of the academic calendar.

The way forward

For Engineering to deliver the desired results as a specialized branch of study dedicated to the welfare of the society, the youth should have clarity on what it is all about. It is a myth that Engineering is all about Science only. In fact, Engineering is a mix of science and art in a different form. Application of the technical knowledge to the real life requirements is where the artistic factor comes into play. It is the art of applying scientific and mathematical principles (amassed during the course), experience, judgmental skills, and commonsense to make things that benefit the society. An engineering program should always start with the basis that "real" engineering is not limited only to technical problem solving – it goes beyond the ability to think analytically. There should be proper counselling sessions focusing with identification of the traits and interests of the youth to start with. One should not select a branch of study merely on the basis of the market trends. The first step in learning engineering is to choose a specific discipline that interests you. Each discipline has its own unique set of skills, knowledge, and applications, so it's important to choose one that aligns with your interests and goals. For example, if one has aflair for designing and building machines, mechanical engineering should be a good fit. However, these decisions often get over weighed

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with external factors like the lucrative scope of other branches like Computer Science and Information technology which eventually do notresultina favourable outcome.

The Cognitive and metacognitive insights of learning Engineering is another area that one needs to align the talent getting admitted into the college. A proper foundation which facilitates Metacognition as "thinking about thinking" to foster the ability for monitoring and controlling one's cognitive processes towards design thinking should be the next step. The tendency of high performers presenting better metacognitive abilities (especially control) than low performers in academics is not uncommon. However, the ask here is to ensure there is parity in application of the Classroom learnings among stall the students which will play a major role in living upto the expectations of the prospective employers. Given the potential benefits of metacognition, it is of great importance to have a better understanding amongst the teaching faculty of how metacognition works and of how faculty development programs can prove to be useful. Even though a large body of literature on metacognitive training could be available across various public platforms, we still need to have clear insights about what works best for the process of imparting Engineering education and why. These literature will need further investigation through the lenses of external validity, domain generality and metacognitive training with some cases of theoretical discrepancies that may have to be aligned.

The process of learning engineering is not limited only to Problem solving, computational thinking, reasoning or visuospatial thinking. There are various additional disciplinary and interdisciplinary practices involved in this process which need to be methodically executed. These interfaces amongst different engineering disciplines is quite common in the industry and development of this mind-set is of utmost importance. Students should have clarity on why they need to understand the content of the subjects of different engineering branches in the initial stages of the education curriculum so that they study these subjects without any degree of flippancy. To have a better insight into the amelioration of the learning methods for engineers of today's era, we need to understand the approach of our external peers which should not be having any boundaries or limitations.

Research-Based learning is another important are a which has acritical role in developing an engineering mind-set amongst the students. A sample case considered here is the impact of this approach as evident in IIT-Bombay making into the top 150 global rankings which was mainly driven by the generation of 1, 43, 800 citations from 15,905 academic papers, thereby registering a research growth of approximately 17%. The institute's research quality is further demonstrated by 30% of its output which was published in the top 10% academic journals by impact. This figure surpasses the global average by 6% and is a staggering 15% higher than the average among Indian institutions which is quite a remarkable feat.

There is yet another concern related to askewed international faculty ratio and international student ratio in the Indian colleges doing rounds in various forums. But Prof. Subhasis Chaudhuri, Director ,IIT-Bombay has a different view to this, which Itooam of the same opinion. As per the views expressed by Prof. Subhasis Chaudhuri In an exclusive interview to News18, "Through these parameters, what they want to measure is diversity in your institution. The way these ranking agencies measure it is just looking at the colour of your passport. We have more diversity than say Europe or anywhere else.

Now, about foreign faculty; what one should be looking at is academic diversity, not passport diversity. The US has people coming from all over the world and has a number of those teaching from say China or India and many other countries. In India, at IIT-B, of the 700-odd faculty, we pan across the country, we have people from Arunachal, Kerala, Gujarat, and Kashmir, among others. We have regional, cultural and linguistic diversity, so what other diversity do you want."

The alignment of the curriculum with the industry trend is another grey area which needs to be thoroughly evaluated before taking the plunge. Today, we see a lot of emphasis on specializations. But do we actually need to emphasize so much on this aspect in the Under-graduation syllabus or are we missing out on something more important here. The following quote is yet another offering of food for thought–

"I believe that at the undergraduate level, we should not be over-specialising. What we need to develop at this stage is core competence, which can take you to whichever direction you want because when you are so young, you may not understand what exactly AI or data science entails. So you should go for fundamentals and many of these things evolve.

For example, what is computer science engineering today didn't exist the same way many years ago. It evolved and was standardized over time. It's better to make a base of fundamentals first and may be one can domain or in data science or a Masters to

know which part of it one would want to go further into. So I would wait for two more years at least to see how it's evolving.
It has happened earlier when many people jumped to IT, even we started a course in it and the neventually we had to close it. One has to get the fundamentals right."(SC,News18)

CONCLUSION

Today's engineering students face a variety of challenges starting from time management, Procrastination, career confusion, etc. The earlier they get help, the more likely it is that their time in the campus meets the intent for which they had enrolled. Although the analytical facts, figures and recommendations mentioned above are only some rays of light into the darkness of the problem, implementation of the corrective measures and regular monitoring holds the key to the problem. There is definitely no single solution to this problem. One has to complete the circle starting from identification of the problem, analysis of the findings, implementation and feedback with continual monitoring to brighten the Engineering Education system. Only then will the seeds planted by Great Engineers like James Watt, Imhotep, M. Visvesvarayya, and the endless list of the geniuses of their times bear fruit and uplift the light of this field.

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