CRITICAL STUDY ON ROLE OF ENGINEERING MATHEMATICS IN ENGINEERING PRACTICES AMONG ENGINEERS OF MAHARASHTRA STATE

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ABSTRACT:

Today more people choose engineering career than earlier days. The challenges of engineering careers are job, pay, originality, and a preference for problem-solving are, crucial factors in students' decisions to pursue engineering careers. Mathematics as a subject is unique, compare to other subjects. Mathematics is an essential subject , contributes in engineering practices among engineers. This paper reflects critical study of engineering mathematics in engineering practices among engineers of Maharashtra state.

KEYWORDS: mathematics, technology, communication, occupations

INTRODUCTION:

Mathematics has long been recognized as the essential subject supporting engineering practice. Furthermore, typical engineering occupations may not be as appealing to modern young people as they were two decades ago. The general use of technology and accompanying habits, as well as the interests, skills, and activities of young people, have all significantly changed over the same period of time. With the advent of cell phones, iPods, and iPads, the typical modern teen now lives in a world where communication, information, and entertainment are easily accessible whenever they want, from any location, and at a low cost. However, few engineers who are now working claim that the mathematics they learned has little bearing on their jobs . Much of the research on engineering career choice that is currently available focuses on women's participation in engineering because of the underrepresentation of women in the field. In India, women enrol in university engineering programmes at a rate of about 20% yearly.

REVIEW OF LITERATURE:

In their paper, Pepin et al. (2017) discuss the most recent international research on innovative teaching and learning practises in mathematics in engineering education. They also aim to

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gain a deeper understanding of the traits of existing practises that can guide the creation and application of new, innovative ones in the future. In addition to introducing the papers in this special issue, the objective of this review paper is to present a current overview of this developing area at the nexus of mathematics and engineering education. To direct this paper, we provided the following three review questions: (1) How can current math practices (teaching, learning, and study) in engineering education be categorised in terms of innovation? (2) What exactly are the "resources" (cognitive, material, digital, and social) that are used?

In their research work, Eileen et al. (2012) noted that during the past 20 years, fewer school graduates in Ireland have chosen to pursue professional engineering careers. Students who want to enrol in professional engineering degree programmes must be proficient in advanced secondary mathematics. Despite this, just 16% of Irish secondary school pupils choose to take the higher-level mathematics Leaving Certificate exam. The "main academic hurdle" in producing a supply of engineering graduates is frequently thought to be mathematics. Although mathematics is acknowledged as a fundamental knowledge area underpinning engineering practise, some practising engineers think the math they learned is unrelated to their line of work.

The choosing of an engineering career is a major theme in this study. Despite promising job opportunities, there has been a fall in both the study of mathematics in schools and engineering at the university level, according to a substantial body of published material. The United States, Australia, Europe, the United Kingdom, and India all share this pattern.

While choosing a career during a person's senior year of high school is among the most important decisions they will ever make, choosing a career is influenced by a variety of factors, such as the decisions they make (like which subjects to study in school), their values, their successes and failures, their social class, and their interests, strengths, and capacities (Ginzberg et al. 1951). Career growth can be seen as an evolutionary process with three phases, according to Ginzberg, Ginsburg, Axelrad, and Herma (1951). These phases include fantasy, tentative, and actual. During the fantasy stage, a young child makes job decisions based on impulses and short-term requirements without understanding the realities of the profession. The family's opinions toward the behaviours and activities during this time play a significant impact in shaping the child during the fantasy stage as the youngster starts to role-play these occupations. The child's profession choices are based on personal factors, including interests, abilities, and values, and are normally made when they are between the ages of 11 and 17. Teenagers start to assess the available vocations, the characteristics of those who hold them, and the opinions of others about those individuals and their occupations during this time. The teens take into account their interests and hobbies, skills and talents, pay, the satisfaction that particular jobs provide, the work schedule, and other value-related factors. The early years of adulthood, which are the realistic time, are when the person starts to combine their own requirements with the opportunities, demands, and constraints of the jobs that society has to offer. The person chooses their exact career or the industry in which they want to work during this time. The decision is a compromise between the person's interests and abilities, as well as an attempt to as closely as possible satisfy their values and aims (Ginzberg et al. 1951).

Low enrolment in engineering programmes is caused by "bad experiences with scientific and engineering education among students generally, combined with a negative perception of and inadequate knowledge about professions deriving from the study of science and engineering" (Roberts 2002). According to the social cognitive career theory, more career decision confidence is associated with both professional knowledge and a better fit between one's self-identity and career image (Lent et al. 2002). In their "Draw an Engineer Test," Knight and Cunningham found that many pupils, especially younger ones, connect engineers with repairing automobile engines, doing construction labour, and being masculine. (Knight and Cunningham 2004). Studies on how young people view engineers generally reveal that engineers are typically male and that their work is viewed as fixing, constructing, creating, or working with vehicles, engines, buildings, and tools. It is a herculean task to encourage learners' students to take admission in engineering because of these myths and stereotypes. Additionally, research reveals that many engineering students lack knowledge of various career options. The lack of qualified individuals in the fields of science, technology, engineering, and mathematics has been the subject of numerous reports , concentrate on the symptoms rather than the causes, such as the lack of engineers and the decline in students who choose to study According to them, a decline in university enrollment in engineering education was caused by misconceptions, mystification, and misunderstandings about what engineers do as a result of engineering having multiple meanings and occurring in a variety of contexts (Prieto et al. 2009). Prieto, Holbrook, Bourke, O'Connor, and Husher (2009) identified four main factors that contribute to low enrolment in engineering degrees after reviewing research literature on how students' interest in mathematics, science, and engineering leads to enrolment in engineering education. These include national investments, information sources, educational opportunities, and public attitudes of the industry. They claim that parents, family members, and the school career advisor shape pupils' perceptions of the engineering field. They state that there is general agreement that "college graduates who become teachers have somewhat poorer intellectual ability on average than those who do not go into teaching" and that sizable portions of middle school math and science teachers lack majors or minors in those disciplines. As a result, students' ability to learn science and math is hampered. When they consider all the variables, they claim that increasing students' interest in mathematics and science and connecting these subjects to engineering is crucial. They think the key to expanding enrollment in engineering education is to improve students' experiences in mathematics and the supporting sciences (Prieto et al. 2009). According to McWilliam, Poronnik, and Taylor (2008), schools and universities whose curriculum, pedagogy, and assessment remain "outside" will become increasingly irrelevant to the modes of learning and social engagement that young people choose as well as to the future of their work. This is because math and science education are crucial to students' interest in these fields (McWilliam et al. 2008).

Despite the fact that engineering practice is becoming increasingly important to society, the

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engineering profession is not as respected as other professions. Due to the "undergraduate nature" of the curriculum, the "evolution of the profession from a trade," and the all-too-common tendency of industry to view engineers as "consumable commodities, discarding them when their skills become obsolete or replaceable by cheaper engineering services from abroad,"

Duderstadt (2008) attributes this poor reputation to these factors. In addition, students' interest in engineering occupations is dropping in comparison to other professions like commerce, law, and medical, which is indicative of the poor public esteem of the engineering profession. Because the profession and the educational system that supports it have not kept up with the changing nature of both our knowledge-intensive society and the global marketplace, modern engineers no longer hold the leadership positions in business and government that their forebears did in the 19th and 20th centuries. In fact, the vulnerability of the degradation of the engineering profession in America and with it our nation's technological competence and capacity for technological innovation is raised by the offshoring of engineering jobs of increasing value and the outsourcing of engineering services of increasing complexity .

The National Academy of Engineering (NAE) discovered that there is no easily recognisable "public face" of engineering in a study on perceptions of engineers and engineering. They added that despite engineering being all around us, seeing it requires a "strong awareness." According to the NAE, some engineers "may be quite severe on themselves" and consider themselves to be "nerds and geeks." One of the study subjects claims "People outside of the field have a difficult time understanding what we do, and we also don't express it well. They perceive engineering to be a series of complicated technical concepts that are also uninteresting ". According to the NAE, issues conveying engineering are a result of the perceived difficulty of engineering's technical parts, particularly mathematics and science (National Academy of Engineering 2008).

According to Jane Grimson (2002), engineers' failure to recognise the significance of the context-sensitive view undermines the engineering profession and the context-free approach of engineering science is not easily adaptable to solving real-world problems. According to her, society favours engineers who can apply their expertise across disciplines, and she emphasises the significance of engineers having strong non-technical communication skills. Engineers, according to her, should be able to communicate technological issues. Grimson emphasises the necessity for the engineering profession to stay current and to gain business, financial, marketing, and management capabilities given the rate of development of new engineering knowledge (Grimson 2002).

Objectives of Study:

Objective of this research is to analyse the role of Engineering Mathematics in Engineering Practices and importance of Mathematics in Engineering Careers.

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RESEARCH METHODOLOGY

Data Collection Methodologies

The survey questionnaire, semi-structured interviews, and secondary data gathered through a review of the literature were selected as the data collection tools for this mixed methods research study.

The best strategy for gathering quantitative data from a sizable population is a survey questionnaire approach, in which all participants are asked the same questions. Survey questionnaires are ideal for automatic data collecting from a large number of respondents and online management. Experiments, cross-sectional studies, or longitudinal studies are not appropriate because the quantitative part of this study is mostly about measuring engineers' existing mathematics usage and their motivation to use a mathematical approach in both their career decision and their work.

Interviews are a useful tool in qualitative research for learning about participants' behaviours, attitudes, and feelings regarding a certain subject. Participants are given the chance to express their opinions during interviews, which also provide the researcher the freedom to delve deeply into subjects related to the study questions. Interviews are a useful tool for gathering information about engineers' attitudes of mathematics affinity, which is a central issue in this study. Open-ended questions are used in qualitative interviews because they enable the interviewer to explore and probe within inquiry areas related to the research questions and because interviewees are free to respond in their own language.

Study Population

It was decided to restrict this study to professional engineers working in Bhandara of Maharashtra state. This research focuses on the role of mathematics in engineering practise.

Engineers typically fall under a relatively broad group of disciplines, and the term "engineering" is often used to refer to a wide range of positions and educational backgrounds. Engineering frequently comprises duties taken on by non-graduates in addition to the typical graduate fields of civil, electrical, electronic, mechanical, chemical, computer, and software engineering, for example.

39 out of the 365 valid responses (from Bhandara in Maharashtra) are female respondents.

FINDINGS OF STUDY:

The interview data shows that the process of learning mathematics is different to learning other school subjects. Engineers say that mathematics learning is a "process" of problem solving and/ or application of mathematics and that "understanding" is an essential part of learning unlike other school subjects where learning is about "information retention" and "regurgitation". The majority of engineers describe mathematics as a "process" or an activity: mathematics is "a very well defined process coming to a well-defined solution"; mathematics is a "logical process" ; mathematics is the "process" of solving problems and students have to "figure it out for themselves"; mathematics is a "process of understanding"; learning mathematics is "trying to work it out and get the solution" ; mathematics is breaking everything down into bite sized bits"and mathematics learning involves "getting on top of various concepts" and mathematics is different from other subjects because "maths has an application".

All engineers are of the view that mathematics is different from the majority of other school subjects. There is a view that mathematics is different because it "looks different" to many other school subjects. Mathematics looks different because compared to the interesting stories in many other subjects, mathematics consists of formulae and symbols. Mathematics learning requires understanding the concepts while learning many other subjects is about retaining information. Engineers find it easier to learn mathematics by developing understanding compared to memorising as in other subjects. The processes of learning mathematics and problem solving require a lot of practice and hence mathematics learning is time consuming. A major difference between mathematics and other subjects is that mathematics focuses on getting the right answer and other subjects lean towards subjective analysis. Engineers like having "a right answer" because it removes the subjectivity from exam grades. Mathematics has an extra dimension compared to other subjects; mathematics learning involves application in different contexts or situations.

Nineteen of the twenty engineers say they had good mathematics teachers at some stage throughout their school years. The engineers express a very strong view on the importance of good mathematics teaching. The ability to communicate mathematics is the predominant feature of good mathematics teaching. Many engineers also noted that their mathematics teachers encouraged the students, challenged the students, knew mathematics and they were strict. When asked to describe the characteristics of good mathematics teachers generally, the engineers say that good mathematics teachers are "positive" about mathematics and they encourage the students to engage in the subject, they know mathematics, they are able to teach students with differing abilities and learning styles, they show students the relevance of mathematics in the real world, they are attractive to students and they are organised and disciplined.

Many engineers say that good mathematics teachers transformed their mathematics learning and their enjoyment of the subject and many others note the importance of a good grounding in mathematics. In addition to mathematics learning, the engineers' positive feelings about mathematics are a very significant outcome of having had good mathematics teachers.

The importance of mathematics to engineers is related to the technical nature of their work and their trust in mathematical solutions. Mathematics is different compared to other school subjects.

"Good" mathematics teachers communicate mathematics well; they are positive about mathematics and teaching; they know mathematics; they are able to teach a broad profile of students; they illustrate the relevance of mathematics; they are interesting; and they are organized and strict.

Mathematics education contributes positively to engineer's work and increase confidence in mathematical ability, these are the main motivators for engineers to use mathematics.

Engineers' work is varied and involves a variety of skills, including problem-solving, "larger picture thinking," the use of computational tools, reuse of solutions, data analysis, "real world" applicability, integrating technological components, managing projects, and conveying results. Engineers use a high level of mathematics in their work.

Statistics and probability play important in engineering practice.

CONCLUSION:

This study's data is based on the experiences of practicing engineers with engineering education and engineering practise. It provides new insights into the categories of mathematics required to engineers in their line of work as well as their attitudes toward the subject.

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