

The Teaching and Learning of Mathematics in English within Tertiary-Level Engineering Education Programs in Bangladesh: A Situational Review

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HOW TO CITE: ABSTRACT

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International Journal of
Special Education, 41(21s),
1574-1595

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This article presents a situational analysis of the mathematics curriculum and instruction in higher education engineering programs in Bangladesh, emphasizing the problems students encounter in learning mathematics delivered in English. The purpose of this review is to identify the key barriers to effective mathematics education and propose actionable solutions for improvement. Methodologically, the review synthesizes current literature, educational practices, and feedback from students and faculty, helping to outline the multifaceted issues related to language proficiency, cognitive challenges, and socio-economic factors. The findings reveal that language barriers significantly impede students' comprehension of complex mathematical concepts, while inadequate curriculum alignment with international standards further exacerbates the challenges faced by learners. Furthermore, it underscores the imperative for novel pedagogical approaches and comprehensive faculty development initiatives to improve instructional efficacy. Based on these findings, the article proposes several recommendations, including curriculum enhancement, the implementation of supportive language programs, and development of faculty training initiatives that focus on pedagogical strategies suited for English-medium instruction. The study's implications underline the urgent need for a comprehensive reform in mathematics education policy, ensuring inclusivity and better alignment with global educational standards. By addressing these areas, the article asserts that stakeholders can significantly improve the educational experience and outcomes for engineering students in Bangladesh, enabling them to meet the demands of an increasingly complex and competitive workforce.

Keywords: Tertiary level Engineering Education, Bangladesh perspectives, Mathematics Curriculum, Medium of Instruction

1. Introduction

Mathematics is often called the language of engineering and is the essential foundation for most engineering principles. From analysing structural integrity to modelling complex systems, the technical skills necessary for effective problem-solving in engineering fields are based on mathematical concepts (Nawab, 2023). Mathematics plays a huge role in engineering education as it develops analytical, quantitative and critical thinking skills required to solve real-world engineering problems (Ghosh & Zaman, 2022). Bangladesh's economy is highly related to the development of technology and infrastructure and therefore, it is important to develop students' strong mathematical competencies so that competent engineers can promote innovation and development in different sectors (Haque, 2022). In recent years, English medium instruction (EMI) has been more and more adopted by the higher education institutions of Bangladesh particularly in engineering degrees. With the globalisation of education and business, students have more access to foreign resources, research and practices, previously only available in English-speaking countries (Mahmud & Rahman, 2021). The main objective of this program is to improve the employability of graduates in a competitive labour market, but there are some issues, especially in some disciplines such as mathematics, where technical skills and language skills co-exist (Amin & Rahman, 2022). Many students may have had their previous education in Bengali and often find it hard to comprehend the complex mathematical subjects entirely when taught in English, leading to differences in the learning outcomes (Choudhury, 2022).

This review aims to present a thorough review of the current status of mathematics teaching in the English language engineering programs of Bangladesh. The research aims to identify the main difficulties that students and professors face in this context, thru an evaluation of the curriculum and the pedagogical practices. This means knowing the width and depth of the mathematical concepts being taught and the quality of the pedagogical approaches used and their connection with international engineering standards (Rahman, 2021; Hossain & Rahman,

2022). This review adopts this perspective to identify weaknesses and suggest improvements in the quality of tertiary mathematics instruction.

This review is not only important for scholarly debate but also because it is a serious attempt to influence educational policy and practice in Bangladesh. For the country's goals of economic growth and technical development, it is important that engineering graduates are equipped with strong mathematical skills (Khan, Rahman, & Sultana, 2018; Kabir & Jamal, 2023). This assessment tries to make stakeholders more aware of the important aspects of mathematics education that need attention and to offer ideas for educators and policymakers (Gibbons, 2020). The review findings are expected to motivate collaboration between teachers, organisations and representatives of the government to develop policies to address problems and promote sustainable improvements in the teaching of mathematics (Uddin & Hossain, 2023).

To conclude, in the effort to establish Bangladesh as a growing center for engineering and technology, it is essential to establish a strong mathematical foundation thru effective English-medium education. This situational evaluation is meant to contribute to the continuing discussion of educational reform with the ultimate aim of improving the mathematical abilities of engineering students and preparing them for the challenges of a rapidly changing global context. By addressing these issues, we can have engineering graduates with strong quantitative skills who can succeed in a global setting.

2. Current Situation of Mathematics Education in Bangladesh

2.1 Historical Context of Mathematics Education in Bangladesh

Mathematics education in Bangladesh has a long history that goes back to the establishment of formal schooling during the British colonial period (Nizam, 2019). Initially, the mathematics curriculum was heavily influenced by the British educational system with an emphasis on rote learning and memorisation (Adnan & Khatun, 2021). After independence, the emphasis was on developing a more relevant and localised curriculum for the scientific and technological development of the country. In the 1970s, the

national education policy was adopted to improve the quality and accessibility of mathematics education. However, it faced numerous issues, such as limited resources, lack of proper training for teachers, and inadequate instructional materials (Hossain & Karim, 2020). However, the problems of curriculum rigidity and teaching methods still remained deeply ingrained in education system. A timeline of this history is shown in Figure 1 which shows how the teaching and learning of Mathematics in Bangladesh has evolved from the indigenous, tradition based learning systems to the national curriculum of today.

The emergence of private universities since the early 1990s has helped diversify educational approaches, including the introduction of elective courses and modern teaching methods (Bashar, 2021). But a lot of engineering programs still use traditional teaching methods that involve large lectures and do not encourage active student participation or critical thinking. This often makes it difficult for students to incorporate mathematical principles into engineering applications and thus fails to prepare them for the rigorous of the profession. Table 1 provides a

summary of these historical periods and outlines the main characteristics, curriculum and institutional developments, and educational impact associated with each era.

The years have seen many changes in mathematics teaching in Bangladesh. It was a traditional system, an indigenous system that has grown into a formal national curriculum. Colonial rule introduced the country to western ways of mathematics and formal institutions of instruction. After independence, Bangladesh concentrated on the development of curriculum suitable to its own needs. To this end, the National Curriculum and Textbook Board (NCTB) were established as the main body for standardizing mathematics education across the country. The present reforms are focused on problem solving, creativity and competency-based learning. Technology is also a key player in this transformation and together these developments are slowly bringing Bangladesh's mathematics education in line with international standards.

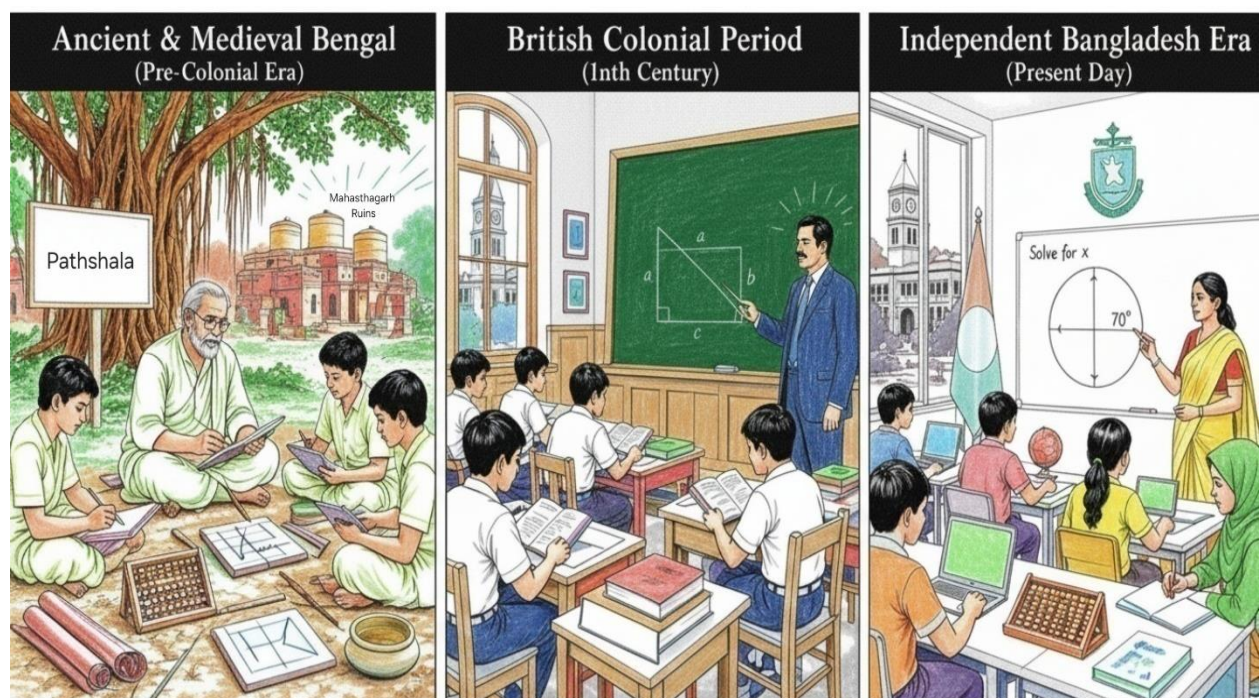


Figure 1: Historical Timeline of Mathematics Education in Bangladesh

Table 1: Summary of Historical Periods and Characteristics of Mathematics Education in Bangladesh

Historical Period	Major Characteristics of Mathematics Education	Curriculum and Institutional Development	Impact on Mathematics Education	References
Ancient and Medieval Bengal (before 1757)	Mathematics was taught as part of traditional education systems such as <i>tols</i> , <i>pathshalas</i> , <i>maktabs</i> , and <i>madrasas</i> . Learning focused on arithmetic, measurement, astronomy, and practical calculations for trade and administration.	Indigenous education systems emphasized basic numeracy, Sanskrit mathematical traditions, and Islamic contributions to arithmetic and astronomy.	Established the foundation of mathematical knowledge through traditional learning practices.	Alam (2015); Khan (1996)
British Colonial Period (1757–1947)	Western-style mathematics education was introduced through colonial educational reforms. Mathematics became an important subject in formal schools and colleges.	The establishment of modern educational institutions introduced European mathematics, algebra, geometry, calculus, and scientific methods. Institutions such as universities and government schools promoted formal mathematics education.	Shifted mathematics learning from traditional systems toward structured classroom-based education.	Nurullah&Naik (1951); Ahmed (1987)
Early 20th Century Bengal Education Movement	Mathematics education expanded through secondary schools and higher education institutions. Emphasis was placed on examination-based achievement and academic mathematics.	Universities and colleges developed mathematics departments and produced trained mathematics teachers.	Increased access to advanced mathematical studies and professional mathematics teaching.	Ahmed (1987)
Pakistan Period (1947–1971)	Mathematics education followed the education policies of Pakistan with increasing emphasis on science and technical education.	School mathematics curricula were standardized, and mathematics became compulsory at various levels of education.	Strengthened the role of mathematics in science, technology, and higher education.	Government of Pakistan (1959); Ahmed (1987)
Post-Independence Bangladesh (1971–1980s)	After independence, Bangladesh revised educational materials to reflect national needs and expanded access to mathematics education.	The Bangladesh School Textbook Board revised textbooks and curricula after 1971. The development of national textbooks supported uniform mathematics education.	Created a national identity in mathematics curriculum and improved accessibility of learning materials.	NCTB (2023); International Mathematical Union (IMU, 2024)

Historical Period	Major Characteristics of Mathematics Education	Curriculum and Institutional Development	Impact on Mathematics Education	References
Formation of National Curriculum and Textbook Board (1983)	Mathematics curriculum development became centrally organized under a national authority.	NCTB was established through the merger of curriculum and textbook organizations to prepare national curricula and textbooks for primary and secondary education.	Improved curriculum consistency, textbook quality, and nationwide implementation of mathematics education.	NCTB (2023)
Curriculum Reform Period (1990s–2010)	Mathematics education gradually shifted from content memorization toward competency-based learning approaches.	Curriculum reforms introduced new mathematics textbooks, improved assessment methods, and expanded teacher training initiatives.	Encouraged conceptual understanding and application-oriented mathematics learning.	Ministry of Education Bangladesh (2010); IMU (2024)
Modern Mathematics Education in Bangladesh (2010–Present)	Mathematics is compulsory from primary to secondary levels, with increasing emphasis on creativity, problem solving, and technology-based learning.	NCTB develops and distributes mathematics textbooks for national curriculum streams. Digital resources and competency-based curriculum reforms have been introduced.	Mathematics education supports STEM development, engineering, science, and national technological advancement.	NCTB (2023); IMU (2024)
Higher Education and Research Development	Mathematics education expanded through universities offering undergraduate, graduate, and research programs.	Public and private universities provide mathematics programs, while organizations such as the Bangladesh Mathematical Society promote research and teacher development.		

2.2 Examination of the Curriculum at Engineering Institutions

Bangladesh's engineering programs' mathematics curricula have drawn criticism for not being in line with industry demands and international engineering norms (Alam, 2022). Traditional subjects like calculus, linear algebra, differential equations, and statistics are usually covered in today's curricula. They frequently overlook modern applications and multidisciplinary teaching strategies, nevertheless, which are becoming more and more important in the

engineering sector. According to a research by Uddin et al. (2021), both teachers and students have expressed dissatisfaction with the curriculum's lack of exposure to computational tools, mathematical modeling, and problem-solving strategies—all of which are critical in today's technologically advanced environment.

The curriculum's design also calls into question how well it fosters a thorough comprehension of mathematical ideas. Teachers have observed that although children may do well on tests, they frequently lack the practical and creative

application of mathematics (Mollah, 2023). Furthermore, the quality of mathematics education varies significantly throughout institutions, particularly between public and private colleges. Although they have not yet gained widespread acceptance, several private colleges have started to create cutting-edge curricula that incorporate project-based learning and real-world applications (Shahidullah & Hasan, 2020).

One important element affecting how well mathematics is taught in Bangladesh is the language of teaching. Bengali was used as the main language of instruction in most schools for many years. But the trend toward English-medium education has accelerated, especially in private university-affiliated engineering schools (Mahmud & Rahman, 2021). The goal of this shift is to make graduates more employable in a labor market that is becoming more global. But it has brought with it special difficulties, especially when it comes to teaching mathematics. Even because EMI gives students access to a wider variety of educational materials, many students struggle to understand difficult mathematical ideas while also navigating the English language, which is frequently not their native language. Students commonly struggle to understand mathematics problems presented in English, leading to misunderstandings that impair their overall knowledge and performance in the subject, according to research by Pervez et al. (2022). Additionally, by failing to effectively communicate concepts, English-proficient teachers who lack a solid foundation in mathematics education may unintentionally exacerbate these difficulties (Chowdhury, 2020).

The dilemma is made worse by Bangladeshi students' varied linguistic backgrounds, as many of them have little exposure to English-language mathematical vocabulary when they first start college. Accordingly, pupils from rural or underprivileged urban backgrounds are disproportionately affected by the irregularity in language proficiency, which further worsens the performance gap (Khan & Hossain, 2021). Thus, implementing EMI in mathematics education has significant ramifications that call for the creation of all-encompassing support networks that give

students the cognitive and language abilities they need to succeed in their coursework.

Historical legacies and current issues are both reflected in the state of mathematics teaching in Bangladesh's engineering programs. Despite having a solid foundation, the curriculum has to be updated to meet industry demands and international norms. While there are chances for improved learning when English-medium instruction is incorporated, there are also significant language proficiency barriers. Resolving these problems is essential to producing a generation of engineers who possess the mathematical know-how required to make meaningful contributions to the advancement of the country.

3. Analysis of Mathematics Curriculum

3.1 Description of Core Mathematical Topics Covered in Engineering Programs

Various fundamental areas of mathematics curriculum of engineering degrees in Bangladesh are considered important for building up the foundational skills of students. The curriculum is generally grounded in traditional disciplines such as calculus, linear and differential equations, and statistics. Calculus is generally classified into single-variable and multivariable systems, and it is concerned with limits, derivatives, integrals, and their uses in engineering settings (Nawab & Sultana, 2021). Linear maths : Students will learn matrix theory and vector spaces and transformations.

This is very important in understanding systems of equations that you see in engineering analysis. Differential equations are important in modelling and solving real-world problems in engineering sciences such as fluid dynamics and electrical engineering (Rahman et al., 2022). Moreover, statistics and probability also provide students with the opportunity to carry out data analysis, which is a growing skill in engineering fields that use reliability engineering and quality control (Hossain, 2023). However, these are the foundations of theory, but there is a big gap in the contextualisation of these ideas thru project-based learning or problem-solving situations (Ahmed, 2020). The main mathematical topics taught in engineering programs are summarised in Figure 2. Table 2 gives details of the concepts,

engineering applications, and educational importance of each topic, along with references. Mathematics is the foundation of engineering education, both theoretical and practical. In every engineering program anywhere in the world, there are core courses in calculus, differential equations, linear equations, probability, statistics, and numerical methods. Moreover, mathematical modelling is taken as a key in connecting abstract concepts with engineering challenges in the real world. These topics not only prepare students to

think analytically but also develop their ability to compute and solve difficult issues (Kreyszig, 2011; Stroud & Booth, 2020). In recent years, the engineering curriculum has shifted to place more emphasis on computational mathematics, data analysis, and mathematical modelling. This evolution reflects the growing complexity of advanced technology and the interdisciplinary nature of modern engineering practice (ABET, 2023).

Description of Core Mathematical Topics Covered in Engineering Programs

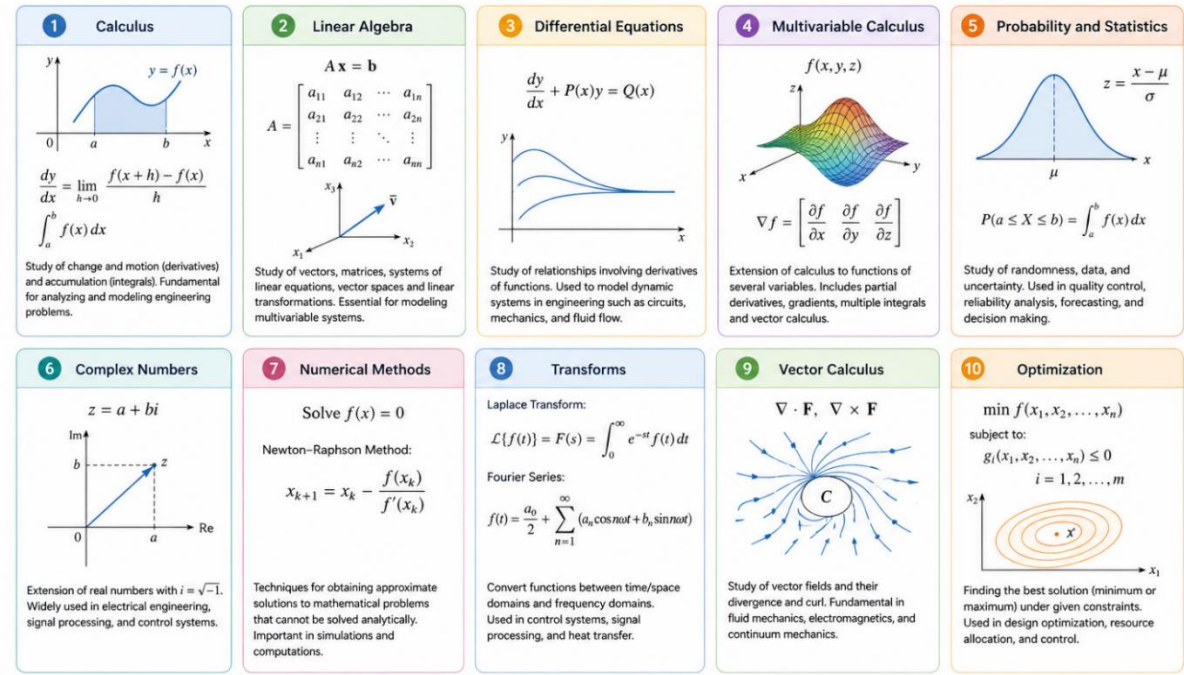


Figure 2: Core Mathematical Topics Covered in Engineering Programs

Table 2: Description of Core Mathematical Topics Covered in Engineering Programs (with References)

Mathematical Topic	Core Concepts Covered	Applications in Engineering Programs	Educational Significance	References
Calculus	Limits, continuity, differentiation, integration, partial derivatives, multiple integrals, vector calculus	Modeling physical phenomena, optimization, motion analysis, heat transfer, fluid mechanics, and electromagnetic systems	Provides the fundamental language for describing continuous change and engineering processes	Kreyszig (2011); Stroud & Booth (2020)
Differential Equations	First and higher-order ordinary differential equations, partial differential equations,	Used in system dynamics, control engineering, vibrations, electrical circuits, structural	Enables engineers to formulate and analyze dynamic systems	Kreyszig (2011); Zill (2018)

Mathematical Topic	Core Concepts Covered	Applications in Engineering Programs	Educational Significance	References
	boundary-value problems	mechanics, and transport phenomena		
Linear Algebra	Matrices, determinants, vector spaces, eigenvalues, eigenvectors, linear transformations	Applied in structural analysis, robotics, computer graphics, machine learning, circuit analysis, and numerical simulation	Essential for solving complex systems of engineering equations	Strang (2016); Kreyszig (2011)
Vector Analysis and Analytic Geometry	Vectors, coordinate systems, vector fields, gradient, divergence, curl, line and surface integrals	Used in mechanics, fluid dynamics, electromagnetics, and engineering design	Provides mathematical tools for representing physical quantities in space	Riley, Hobson & Bence (2006); Kreyszig (2011)
Complex Variables	Complex numbers, analytic functions, Cauchy-Riemann equations, contour integration, residues	Applied in electrical engineering, communication systems, control theory, and signal processing	Helps engineers analyze periodic and frequency-domain systems	Churchill & Brown (2009); Kreyszig (2011)
Probability and Statistics	Probability theory, random variables, probability distributions, statistical inference, regression analysis	Used in reliability analysis, quality control, risk assessment, experimental design, and data science	Develops the ability to analyze uncertainty and engineering data	Montgomery & Runger (2018)
Numerical Methods	Error analysis, interpolation, numerical differentiation and integration, solving nonlinear equations, computational algorithms	Used in engineering simulations, finite element methods, computational fluid dynamics, and optimization	Provides practical solutions for problems that cannot be solved analytically	Chapra & Canale (2015)
Discrete Mathematics	Logic, sets, relations, combinatorics, graph theory, algorithms	Applied in computer engineering, communication networks, information systems, and optimization problems	Strengthens logical reasoning and computational thinking	Rosen (2019)
Optimization Methods	Linear programming, nonlinear programming, constrained optimization, operations research	Used in engineering design, manufacturing systems, transportation, energy management, and resource allocation	Supports efficient decision-making and optimal engineering solutions	Hillier & Lieberman (2021)
Integral Transforms	Fourier series, Fourier transform, Laplace transform, Z-transform	Applied in signal processing, control systems, vibration analysis, and	Simplifies complex differential equations and system analysis	Oppenheim, Willsky & Nawab (2014); Kreyszig (2011)

Mathematical Topic	Core Concepts Covered	Applications in Engineering Programs	Educational Significance	References
		communication engineering		
Mathematical Modeling	Model formulation, assumptions, dimensional analysis, simulation, validation	Applied in environmental systems, mechanical systems, biomedical engineering, and engineering design	Connects mathematical theory with practical engineering problems	Bender (2000); Giordano, Fox & Horton (2014)
Computational Mathematics	Computer-based mathematical methods, symbolic computation, simulation, numerical algorithms	Used in modern engineering software, artificial intelligence, data analysis, and simulation technologies	Develops computational skills required for contemporary engineering practice	Burden & Faires (2011)

3.2 Comparison of the Local Curricula with International Standards

Some significant disparities are observed when the engineering mathematics curricula in Bangladesh are compared with the international norms. Internationally recognised frameworks such as those developed by the Accreditation Board for Engineering and Technology (ABET) in the United States and the UK Engineering Council emphasise the importance of the understanding of mathematical concepts as well as their application in real-life scenarios (Alam, 2022). ABET-accredited programs require students to be exposed to experimental and engineering procedures, and to integrate engineering mathematics into active learning experiences (Rafiq & Jahan, 2021). The curriculum in Bangladesh incorporates similar basic subjects but there is a definite lack of inclusion of advanced computational methods and contemporary applications of mathematics such as numerical analysis and optimization techniques (Uddin & Hossain, 2023). Such features are crucial for students who desire to adapt their skills to international standards particularly since engineering depends more and more on advanced mathematical software and systems modelling (Hasan et al., 2022). Moreover, international curricula often emphasise interdisciplinary learning, which is not as common in Bangladeshi institutions, where disciplines are typically taught in isolation rather than as interconnected elements of engineering problems (Islam & Rahman, 2020). Another factor that contributes to the gap

between local curricula and international standards is the lack of exposure to new technologies and approaches in the classroom. While foreign schools use experiential learning and collaborative projects, Bangladeshi engineering programs predominantly use conventional lecture-based approaches that impede the development of practical skills in real-world engineering contexts (Rahman et al., 2021). Table 3 compares the Bangladesh mathematics curriculum with international standards such as TIMSS, PISA, Cambridge, and IB across several dimensions, highlighting the comparative findings for each.

The mathematics curriculum of Bangladesh is quite comparable with the international standards in terms of content and basic skills. Yet significant gaps still exist, particularly in such areas as mathematical reasoning, inquiry-based learning, technology integration, real-world problem solving and competency-based assessment. International frameworks such as PISA and TIMSS approach mathematics differently: as a tool for reasoning and decision-making, rather than simply a collection of fixed procedures (OECD, 2023; Mullis et al., 2020). Therefore, in the future, curriculum reforms should strive to set higher standards. Such reforms should be aimed at developing mathematical thinking and modelling real-life situations and communicating one's reasoning clearly. They should also inspire students to use their knowledge outside the classroom and on standardised tests.

Table 3: Comparison of Bangladesh Mathematics Curriculum with International Standards

Dimension	Bangladesh Mathematics Curriculum (NCTB)	International Standards (TIMSS/PISA/Cambridge/IB)	Comparative Findings
Curriculum Goals	The mathematics curriculum emphasizes fundamental mathematical knowledge, computational skills, accuracy, and competency-based learning. Recent curriculum reforms aim to develop skills, creativity, and practical applications.	International frameworks emphasize mathematical literacy, reasoning, modeling, problem solving, and applying mathematics in real-life contexts (OECD, 2023).	Bangladesh has moved toward competency-based education; however, greater emphasis on mathematical literacy and application is required.
Mathematical Content	The curriculum includes arithmetic, algebra, geometry, measurement, statistics, probability, and introductory calculus at higher levels.	TIMSS organizes mathematics around major content domains such as number, algebra, geometry, and data while integrating cognitive processes such as knowing, applying, and reasoning (Mullis et al., 2020).	Content coverage is broadly comparable, but international curricula provide more opportunities for exploration and conceptual connections.
Learning Approach	Traditional teaching has often emphasized teacher instruction, textbook exercises, and examination preparation. Recent reforms encourage learner-centered and activity-based approaches.	International standards promote inquiry-based learning, mathematical discussion, collaboration, and conceptual understanding (OECD, 2023).	A shift from procedural learning toward inquiry and student-centered learning is needed.
Problem Solving Ability	Problem solving is included in textbooks and examinations, but many tasks remain routine and algorithm-based.	PISA emphasizes the ability to formulate, employ, and interpret mathematics to solve problems in diverse real-world contexts (OECD, 2023).	Bangladesh requires more non-routine problems, mathematical modeling, and real-life applications.
Mathematical Reasoning	Reasoning and proof are present, particularly at secondary and higher levels, but often receive less attention than computational procedures.	TIMSS identifies reasoning as a major cognitive domain along with knowing and applying mathematics (Mullis et al., 2020).	Greater emphasis on justification, argumentation, and mathematical communication is needed.
Assessment System	Assessment is mainly examination-oriented, focusing on written	International assessments use competency-based evaluation, emphasizing reasoning, application, and	Diversification of assessment through projects, investigations, and formative

Dimension	Bangladesh Mathematics Curriculum (NCTB)	International Standards (TIMSS/PISA/Cambridge/IB)	Comparative Findings
	solutions, accuracy, and achievement scores.	interpretation of mathematical situations (OECD, 2023).	evaluation is recommended.
Use of Technology	Digital tools, mathematical software, and online resources are gradually being introduced but remain limited in many institutions.	International curricula encourage technology-supported learning, mathematical visualization, and digital problem-solving environments.	Technology integration remains an important area for improvement.
Teacher Preparation	Mathematics teachers receive subject-based training, but continuous professional development opportunities vary.	International systems emphasize continuous professional learning and pedagogical content knowledge for mathematics teachers.	Strengthening teacher training programs would improve curriculum implementation.
Real-Life Application	Applications are included mainly in arithmetic, measurement, and statistics.	PISA defines mathematical literacy as using mathematics to describe, explain, predict, and make decisions in real-world situations (OECD, 2023).	More interdisciplinary and contextual mathematics activities are required.
Global Competency	The curriculum reflects national educational priorities and cultural contexts.	International frameworks emphasize creativity, critical thinking, communication, and preparation for 21st-century skills.	

3.3 Identification of Gaps and Challenges Faced by Students

The engineering study programs have a strong mathematical base, but there are many significant problems affecting students' education. One of the major concerns is the variation in students' preparedness and prior experience with mathematics before entering higher education. Many people are from different educational backgrounds with different exposure to higher mathematics. This inconsistency makes it difficult for a large number of students to keep pace with their peers especially in the disciplines that are built on prior knowledge, such as calculus and linear maths (Mollah& Islam, 2022). Another problem is the pedagogical methods used in the teaching of mathematics. Problem-solving and critical thinking abilities are not often developed thru traditional methods of rote memorisation and theoretical principles (Adnan, 2021). Hossain and Karim (2020) note that when teaching

methods do not encourage active participation or the practical use of knowledge, students often report feeling disengaged and less motivated. This disconnect is even more pronounced in mathematics where the significance of real-world applications is often underrated leading to the exacerbation of students' problems in contextualising mathematical concepts (Kabir& Rahman, 2022). Language barriers are a major challenge for students in English medium engineering programs with a strong focus on mathematics. As noted above, many students may not be sufficiently fluent in English to fully understand the complex mathematical language or to be able to engage efficiently with the course materials. Research suggests that language difficulties can cause misunderstandings and errors in understanding mathematical concepts and thereby hinder the learning process (Pervez et al., 2022). This problem requires remedial programs or support mechanisms to fill the language gaps and to assist learners in acquiring mathematics and linguistic competencies.

Lack of interdepartmental collaboration in curriculum design contributes to a narrow view of how mathematics applies to many engineering disciplines. According to Ali and Rahman (2022), the integration of mathematics with other engineering fields such as electrical, mechanical and civil engineering may significantly improve students' understanding of its relevance and importance. This approach would enhance the curriculum and better prepare students for the interdisciplinary work environments common within the discipline of engineering. To summarise, the mathematics curriculum of the engineering programs of Bangladesh includes the basic core courses, but is challenged by the issues of conformity to international standards, pedagogical effectiveness and student preparedness. Addressing these deficiencies is a way to target specific improvements that can lead to better educational outcomes and better preparing engineering graduates to meet the challenges they will face in the workforce.

4. Pedagogical Approaches

4.1 Current Teaching Methodologies Employed in Mathematics Instruction

Figure 3 illustrates a framework of the teaching methodologies discussed in this section, from traditional lecture-based instruction to more student-centred approaches such as problem-based, inquiry-based and technology-enhanced learning. The conventional pedagogical approaches, typically lecture based and rote memorisation orientated dominate mathematics education in the engineering curricula in Bangladesh.

The methodology often focuses on the delivery of theoretical material, with little opportunity for student interaction or involvement in practical problem solving (Adnan, 2021). The teaching and evaluation of courses are often textbook-based which may facilitate a shallow understanding instead of deeper comprehension of mathematical concepts (Hossain & Karim, 2020).

Although the need for reform is acknowledged, many teachers still rely on traditional teaching methods for the most part, due to the pressure of the testing system that is based on memorisation rather than critical thinking (Ali & Rahman, 2022). Limited use of collaborative learning methods such as group work and peer education restrict the ability of students to learn from each

other and develop important communication skills in engineering (Mollah& Islam, 2022).

However, there are some institutions that are starting to use more up-to-date methods of teaching. Project-based learning, flipped classrooms and integration of educational technology are becoming more and more popular, but they are still rare (Nawab& Sultana, 2021). The combination of visualisation and simulation software tools can significantly improve the understanding of complex mathematical concepts (Rahman et al., 2021). Yet, the prevailing pedagogy framework is primarily in favour of conventional methods. This becomes a critical issue for the successful instruction of mathematics in a swiftly changing educational environment. These teaching methodologies are detailed in Table 4, where main features and specific applications in maths teaching are described.

4.2 Evaluation of the Effectiveness of English as the Medium of Instruction

The implementation of English as a medium of instruction (EMI) for teaching mathematics has come with opportunities and challenges. Furthermore, EMI offers students more chances to get involved in scientific research, international academic debates and career opportunities in an increasingly internationalized labour market (Mahmud & Rahman, 2021). The addition of English in engineering curricula is to improve the harmony with global engineering practices and procedures (Hossain, 2023). The effectiveness of EMI is often hindered by students' different levels of English competency. The complex mathematical language presented in English creates barriers to understanding course content and classroom discussions for many students who find it difficult to understand the language (Pervez et al., 2022). This barrier often results in miscommunication and sustains educational inequalities, especially for children from rural or underprivileged urban areas. Furthermore, some faculty members may have problems in delivering knowledge effectively in English, especially if they have not been trained adequately in language proficiency and appropriate teaching methodologies for English Medium Instruction (Chowdhury, 2020). There is often a weak relationship between the medium of instruction and students' conceptual understanding in mathematics, which necessitates additional support systems such as remedial English courses

or instructional resources that address linguistic disparities (Khan & Hossain, 2021).

4.3 Insights from Faculty and Student Perspectives

There are a range of views from staff and students on the current teaching methods in mathematics education. A great number of faculty members desire to adopt more interactive and student-centered pedagogies but report structural barriers such as large class sizes, lack of resources, and inflexible curricula as major challenges (Uddin & Hossain, 2023). Although many teachers acknowledge the importance of fostering students' critical thinking and problem-solving skills, they feel constrained by teaching methods that stress examination results rather than genuine understanding (Rahman et al., 2021). Conversely, students emphasise the need for more engaging and practical ways of learning mathematics. Feedback from surveys shows that students are often put off by the repetitive style

of the lecture and prefer projects that involve collaboration and practical applications for knowledge to be relevant to real-world engineering problems (Khan & Hossain, 2021). Furthermore, students frequently express the need for more support to improve their English proficiency, particularly when tackling complicated mathematics concepts (Ali & Rahman, 2022). To summarise, there are still significant obstacles, although there are increasing pedagogical improvements in mathematics instruction in engineering programs in Bangladesh. An over-dependence on traditional pedagogy stifles deep learning, but many students have difficulty transitioning to English as the medium of instruction. The opinions of professors and students point to the need for structural changes which would be more consistent with the needs and aspirations of today's engineering students in terms of the methods of teaching.

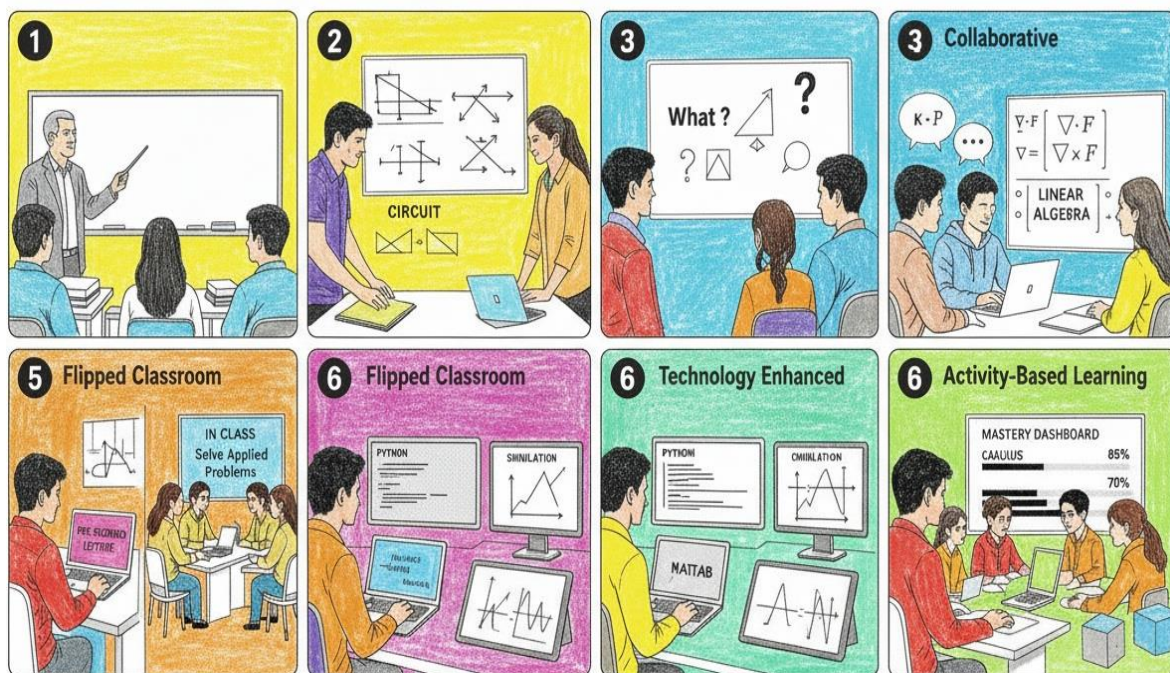


Figure 3: Framework of Teaching Methodologies in Mathematics Instruction

Table 4: Current Teaching Methodologies Employed in Mathematics Instruction

Teaching Methodology	Main Features	Application in Mathematics Instruction
Traditional Lecture Method	Teacher-centered approach focusing on explanation, demonstration, and practice	Used for introducing mathematical concepts, formulas, and procedures

Teaching Methodology	Main Features	Application in Mathematics Instruction
Problem-Based Learning (PBL)	Students solve real-world mathematical problems through investigation and reasoning	Develops critical thinking and mathematical problem-solving skills
Inquiry-Based Learning (IBL)	Students explore mathematical ideas through questioning, discovery, and experimentation	Encourages conceptual understanding and independent learning
Collaborative Learning	Students work in groups to discuss and solve mathematical tasks	Improves communication, teamwork, and mathematical reasoning
Flipped Classroom	Students study instructional materials before class and use classroom time for problem solving	Promotes active participation and deeper understanding
Technology-Enhanced Learning	Uses digital tools, simulations, graphing software, and online resources	Supports visualization, modeling, and interactive mathematics learning
Activity-Based Learning	Learning through practical activities, demonstrations, and mathematical experiments	Connects abstract concepts with real-life situations
Competency-Based Learning	Focuses on mastery of mathematical skills and application of knowledge	Develops mathematical literacy and learner-centered outcomes

5. Challenges Faced by Students

5.1 Language Barriers and Their Impact on Comprehension and Performance

The challenges of language present a significant hurdle for students pursuing mathematics in English-medium engineering programs in Bangladesh. English is the international lingua franca of science and technology. However, many students are from diverse linguistic backgrounds with English being a second or even third language (Mahmud & Rahman, 2021). This linguistic mismatch can significantly hinder students' comprehension of complex mathematical terms and concepts.

Research has shown that students who are not proficient in English might have trouble trying to understand basic mathematical concepts because they are not familiar with the language used in textbooks and lectures (Pervez et al., 2022). For example, complex mathematical terms such as "derivative" or "integral" have specific meanings which can be misunderstood if students only associate them with their translation in their mother tongues. Therefore, students may have difficulty engaging in meaningful classroom discussions or fully understanding the

instructions, which can lead to poor academic performance (Khan & Hossain, 2021).

Moreover, this barrier may increase anxiety and pain during assessments. Students may spend too much time trying to understand the language instead of focusing on problem solving in mathematics and thus affecting their examination results (Chowdhury, 2020). These concerns indicate a need for additional English language support programs to help struggling students with language limitations.

5.2 Cognitive Challenges Related to Learning Complex Mathematical Concepts

Language barriers and cognitive problems are major barriers to the ability of pupils to understand advanced mathematical concepts effectively. By its very nature, mathematics is an intellectual discipline that demands high levels of problem solving skills, abstract and logical thinking. Engineering mathematics involves many challenging concepts such as differential equations, numerical methods and statistical analysis which can create a high cognitive load (Hossain & Karim, 2020). Many students in Bangladesh face problems with the principles of basic mathematics needed to solve higher-order

problems. Lack of prior experience of intensive mathematical training in secondary education can lead to shortcomings in abilities required for understanding more complex ideas (Mollah & Islam, 2022). Cognitive theories suggest that students may become overloaded when they are presented with subjects that exceed their existing cognitive structures. This may result in dissatisfaction and disengagement from the material (Adnan, 2021). The typical method of rote memorising utilised in many universities does not cultivate critical thinking or application abilities. Thus, students often find it difficult to relate the abstract mathematical theories to engineering problems in practice, thereby increasing the cognitive load (Ali & Rahman, 2022). A pedagogical shift to more interactive and application-oriented learning experiences may enhance understanding and facilitate the mastery of complex mathematical topics.

5.3 Socio-Economic Factors Affecting Students' Access and Success

Socio-economic issues have significant impact on students' access to education and performance in engineering mathematics. Children from the underprivileged socio-economic background often face several challenges in a developing country like Bangladesh, such as lack of access to quality education, lack of resources and financial constraints (Uddin & Hossain, 2023). For instance, students might not have access to fundamental learning resources such as textbooks or internet, necessary to understand complex mathematical ideas beyond the classroom.

Furthermore, students may need to work part-time jobs along with their academic activities due to financial constraints, thus reducing their time and focus for studies (Rahman et al., 2021). This additional burden can compound the difficulties in learning mathematics, particularly for children already having difficulty with comprehension. Moreover, socio-economic status may affect students' mental health through high levels of stress and anxiety, which may impact their academic ability (Kabir & Rahman, 2022). Additionally, there remain gender disparities in

access to education in parts of Bangladesh, with female students often facing more socio-economic barriers. Cultural influences may dissuade young women from selecting fields like engineering, thus restricting their choices and engagement in mathematics (Hossain, 2023). Students' challenges in learning mathematics are complex and interconnected. Language barriers limit understanding, cognitive barriers are posed by the difficulty of mathematical concepts, and socio-economic barriers limit access and achievement. These multifaceted issues require a comprehensive strategy, including better pedagogical strategies, specialized language assistance, and efforts to expand educational opportunities for all students, irrespective of their background. Figure 4 illustrates the range of socio-economic factors that shape students' access to, and success in, engineering mathematics education.

6. Recommendations for Improvement

6.1 Suggestions for Curriculum Enhancement

The improvement of mathematics education in English in tertiary level of Engineering Programs in Bangladesh is vital for the improvement of the curriculum. Firstly, the curriculum should be aligned with international standards and include modern topics and practical applications that are relevant to the current needs of the engineering industry (Adnan, 2021). Incorporating such disciplines as data science, computational mathematics, and applied statistics into the educational program can help students be better prepared to deal with challenges in their respective fields (Rahman et al., 2021). Moreover, the presence of multidisciplinary projects that encourage the use of mathematical concepts in solving real-world engineering problems may increase the understanding and retention of knowledge (Ali & Rahman, 2022). Table 5 outlines specific areas for curriculum enhancement, the corresponding suggested improvements, and the expected outcomes for improving mathematics learning in English.

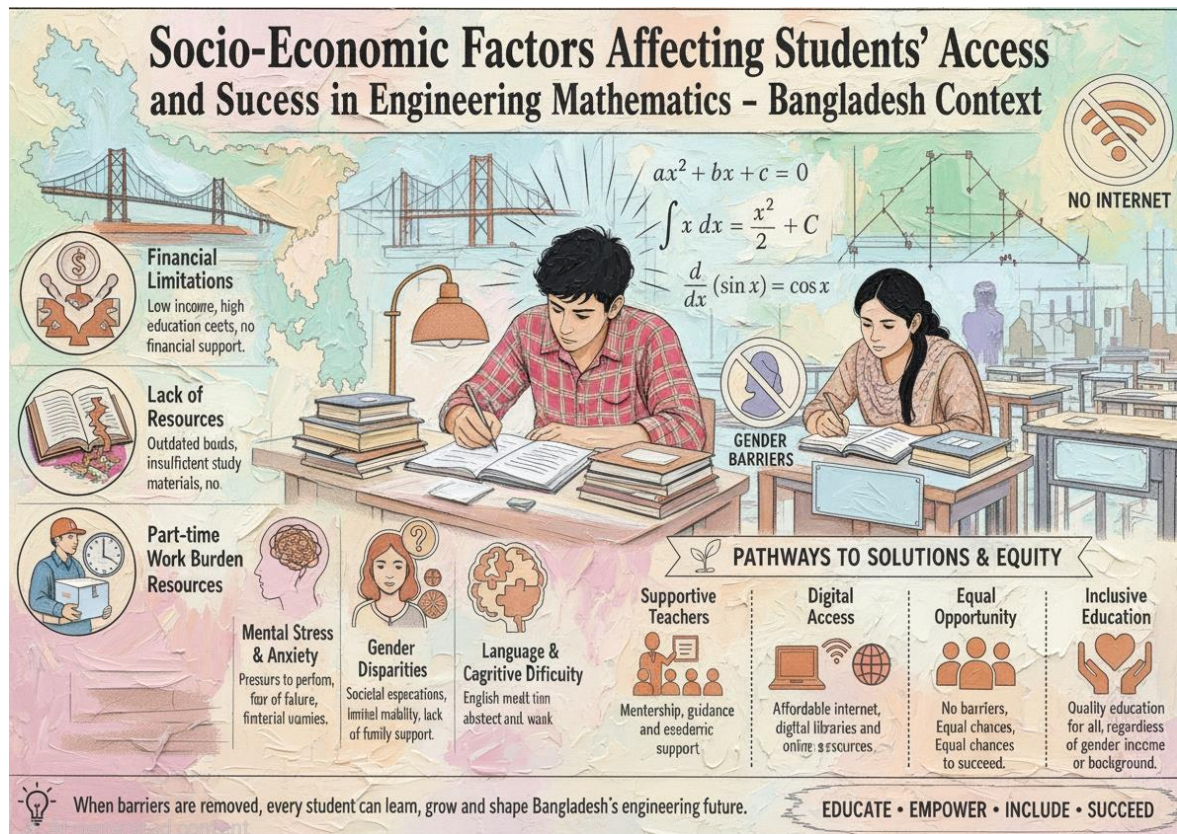


Figure 4: Socio-Economic Factors Affecting Students' Access and Success

Table 5: Suggestions for Curriculum Enhancement for Improving Mathematics Learning in English

Area for Enhancement	Suggested Curriculum Improvement	Expected Outcome
Mathematical English Vocabulary	Introduce systematic teaching of mathematical terms, symbols, definitions, and academic expressions in English	Improves students' understanding and communication of mathematical concepts
Integration of Language and Mathematics	Adopt Content and Language Integrated Learning (CLIL) approaches in mathematics classrooms	Develops both mathematical competence and English proficiency
Problem-Solving Activities	Include real-world mathematical problems requiring reading, reasoning, and explanation in English	Enhances analytical thinking and mathematical communication skills
Teacher Training	Provide professional development on teaching mathematics through English and language-support strategies	Improves teachers' confidence and instructional effectiveness
Interactive Learning Materials	Develop bilingual textbooks, visual resources, videos, and digital learning tools	Supports better comprehension of complex mathematical ideas
Mathematical Communication Skills	Encourage students to explain solutions, write mathematical arguments, and participate in discussions in English	Builds confidence in expressing mathematical reasoning

Area for Enhancement	Suggested Curriculum Improvement	Expected Outcome
Assessment Reform	Include assessment of mathematical understanding, reasoning, and English mathematical expression	Promotes balanced evaluation of knowledge and communication skills
Technology Integration	Use online platforms, simulations, and educational software with English mathematical content	Provides exposure to global learning resources and modern mathematics practices

6.2 Strategies for Effective Teaching in English

The effectiveness of English-based mathematics instruction can be improved by adopting innovative pedagogical methods that are suitable for varied learning styles. It is important that teachers adopt more interactive pedagogies such as collaborative learning, flipped classrooms and technology enhanced teaching techniques (Hossain & Karim, 2020). These methods may improve the engagement of students and encourage participation, resulting in the

comprehension of complex mathematical topics (Mollah& Islam, 2022). Also, the use of more resources such as bilingual glossaries and visual aids can help bridge the language gap, as well as providing context to the mathematical terminology that is being taught (Khan &Hossain, 2021). Regular formative assessments could be used to have continuous assessments of student understanding and modify teaching approaches accordingly. Table 6 summarizes these strategies for effective English-medium mathematics teaching, along with their key features and expected benefits.

Table 6: Strategies for Effective Teaching in English for Mathematics Education

Strategy	Key Features in Mathematics Instruction	Expected Benefits
Mathematical Language Development	Teach mathematical vocabulary, symbols, definitions, and terminology explicitly in English	Improves students' understanding and communication of mathematical ideas
Content and Language Integrated Learning (CLIL)	Combine English language learning with mathematical concepts and problem-solving activities	Develops both mathematical knowledge and English proficiency
Interactive Mathematical Discussions	Encourage students to explain solutions, justify reasoning, and discuss mathematical concepts in English	Enhances mathematical reasoning and communication skills
Problem-Based Learning in English	Use real-life mathematical problems requiring students to read, analyze, and present solutions in English	Develops problem-solving ability and academic language skills
Scaffolding Techniques	Use visual aids, examples, simplified explanations, and gradual language support	Helps students understand complex mathematical concepts through English
Collaborative Learning	Promote group work, peer explanation, and mathematical conversations in English	Builds confidence and improves teamwork and communication

Strategy	Key Features in Mathematics Instruction	Expected Benefits
Technology-Assisted Learning	Use digital platforms, videos, simulations, and interactive mathematics tools in English	Provides exposure to authentic mathematical resources and terminology
Formative Language Assessment	Assess both mathematical understanding and ability to express mathematical reasoning in English	Provides feedback for improving language and mathematical performance

6.3 Proposals for Faculty Training and Student Support

To ensure the effectiveness of English instruction, investment in faculty professional development programs is necessary. Training workshops should be prioritised, particularly on EMI (English as Medium of Instruction) tactics, pedagogical methodologies and content-specific linguistic competencies (Chowdhury, 2020). Faculty members who use good pedagogical strategies can create a more helpful and comprehensible learning environment for students with language problems.

Institutions should adopt language support programs that provide English language courses with an emphasis on the mathematical vocabulary required for engineering (Mahmud & Rahman, 2021). Peer tutoring and mentorship programs can add to student learning by offering individualised support and guidance from more experienced peers. In addition, the establishment of a comprehensive feedback mechanism will enable students to voice their concerns and suggestions regarding the curriculum and teaching methodologies, thereby creating a responsive learning environment that caters to their needs (Uddin & Hossain, 2023).

To be able to reform the teaching of mathematics in engineering education in Bangladesh, targeted curriculum development, effective pedagogy and strong support mechanisms for staff and students are required. Developing a supportive and nurturing learning environment in schools will better prepare students to thrive in both educational and professional settings.

7. The key findings

The main results show that language barriers are a major obstacle for understanding and negatively affect academic performance. The cognitive difficulties are due to the complexity of

mathematical concepts. Additionally, socio-economic aspects impede access to education and success in engineering mathematics. Possible future directions to tackle these challenges include curriculum reform based on international standards, language support programs with bilingual glossaries and visual aids, faculty training on English as Medium of Instruction (EMI) strategies, and establishing peer tutoring and mentorship programs for better learning. Furthermore, policies should be developed to address socio-economic disparities and ensure equal access to education, while ongoing research is necessary to evaluate the effectiveness of these interventions. By focusing on these key areas, stakeholders are able to work together to build a more equitable and effective mathematics education system that better prepares students for success in their educational and professional lives.

8. Novelty of the Study

The originality of this research lies in its combined situational investigation of mathematics teaching and learning in tertiary-level engineering education in Bangladesh where English is used as the medium of instruction. Instead of examining mathematical attainment or English-medium instruction separately, the study combines **curricular arrangement, language barriers, cognitive experiments, pedagogical use, and socio-economic factors** in a single analytical structure. It also relates the prevailing curriculum and teaching practices with international standards and detects specific gaps in mathematical reasoning, real-world application, technology incorporation, and competency-based assessment. Additionally, the study contributes a context-sensitive set of recommendations merging mathematical

language development, Content and Language Integrated Learning (CLIL), problem-based and collective learning, technology-assisted instruction, faculty development, and student-support mechanisms. Thus, it provides a practical framework for improving English-medium engineering mathematics education in Bangladesh and informing institutional and policy-level reform.

9 Significance of the Study

This study is momentous because it addresses an important but relatively underexplored issue in Bangladesh's tertiary engineering education: the teaching and learning of mathematics using English as the medium of instruction. As mathematics is central to engineering education, challenges arising from the interaction between mathematical concepts and English-medium instruction can negatively affect students' understanding, academic performance, and growth of problem-solving skills. The study offers a broad understanding of the challenges encountered by students and faculty, especially language barriers, pedagogical restrictions, curriculum-related issues, and inadequate configuration with global engineering standards.

The findings are likely to help *students, mathematics teachers, engineering institutions, curriculum developers, and policymakers*. For teachers, the study emphasizes the importance of more interactive, student-centred, and language-sensitive approaches, including mathematical language development, CLIL, problem-based learning, scaffolding, and mutual learning. For institutions and policymakers, it gives evidence-based instructions for curriculum improvement, faculty professional improvement, student language-support programmes, and larger educational reform. Eventually, the study can contribute to developing the quality, inclusivity, and worldwide significance of engineering mathematics education in Bangladesh and help train graduates with stronger mathematical and communicative competencies for the global engineering workforce.

10 Limitations of the Study

Though the study provides a broad outline of mathematics teaching and learning using English as the medium of instruction in tertiary-level

engineering education in Bangladesh, it has several limitations. First, as a *situational review*, it mainly amalgamates existing literature, educational practices, and feedback from students and faculty; therefore, its findings cannot establish direct causal relationships between English-medium instruction and students' mathematical performance. Second, the contextual interpretation and discussions were formed by the experiences and perceptions available within the study situations, which may not fully characterize the various conditions of all engineering universities and institutions in Bangladesh. Third, differences in students' English proficiency, socioeconomic conditions, institutional resources, teachers' academic competencies, and offered curricula may affect the applicability of the findings across diverse contexts. Finally, although the study suggests several intrusions, their actual success has not been empirically experienced. Future research should therefore use **larger, multi-institutional, longitudinal, and intervention-based blueprints** to assess the efficiency of the projected approaches. The article itself also identifies the need for constant research to evaluate such interventions.

11. Conclusion

In conclusion, it is emphasized that, the implementation of English Medium Instruction (EMI) in mathematics education in the tertiary level engineering programs in Bangladesh is a necessity and strategic imperative to keep pace with the global education standards and practices. Engineering students who have a good command of the English taught mathematics will be much more competitive in the job markets locally and internationally. This is because the country is moving toward becoming an economic hub. If they are able to develop the capacity to understand mathematical concepts and explain them in English, students will be able to link more effectively to the enormous range of academic material and technological breakthroughs that are largely available in English. Also, EMI will facilitate the cooperation of the members of multinational teams and projects, which will stimulate graduates to be innovative and creative.

There are, however, a number of issues that need to be addressed if EMI is to be successfully implemented in mathematics. These challenges

include ensuring that educators are appropriately trained, generating appropriate learning resources and creating a supportive learning environment for students who have a lower level of confidence in their English language skills. Educational institutions need to invest in the professional development of teachers to make sure that they are able to communicate information effectively and implement pedagogical practices that encourage active learning and critical thinking.

Furthermore, it is of utmost importance to acknowledge that the move to EMI is a gradual process that requires ongoing evaluation and the participation of all stakeholders, namely students, faculty and representatives from the industry. The implementation of more comprehensive EMI in the curriculum of mathematics and engineering can greatly improve the quality of education in Bangladesh, generate highly trained professionals and contribute to the overall development of the country. Therefore, focusing on EMI in mathematics education is an important step toward a more integrated and globally competitive engineering education system in Bangladesh.

Acknowledgment

For providing the setting for discussion and scenario observation in order to prepare this article, the authors are grateful to Ahsanullah University of Science and Technology.

Author Contributions

Mohammad Rukanuddin: Writing –first and original draft, Conceptualization, Methodology,

Investigation, project administration; **Muhammad Sajjad Hossain:** Methodology, Data Curation, Formal analysis, Suggestion, visualization, Formatting, project administration, Supervision, Writing - Review & Editing; **Md. Iftekhar Arafath:** Investigation, resources, Formatting, Writing - Review & Editing, project administration; **Mashrur Mahfuz:** Investigation, Suggestion, software, resources; **Mohammad Shafiqul Islam Bhuiyan:** Investigation, literature review, Fund acquisition, Writing -first draft; **S M Afzal Hoq:** Visualization, validation of Sources information, Supervision, Writing – Review & Editing. All authors have read and agreed to the published version of the manuscript.

Ethical statement

The dedication to carrying out research with honesty, openness, and consideration for all participants is emphasized in this review paper. The writers certify that their conclusions are supported by thorough data analysis and that they fairly reflect the viewpoints of those involved in the educational field. Additionally, by guaranteeing anonymity and informed permission when interacting with teachers and students, the study complies with ethical guidelines with the goals of advancing fair access to learning materials and encouraging a welcoming dialogue about language use in math classes.

Funding

There is no external funding or, internal funding for this research.

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