

How Students Struggle in JEE Preparation in Mathematics

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Abstract

The Joint Entrance Examination (JEE) for India's premier engineering institutions accords significant weight to mathematics, a subject that poses consistent challenges for a large number of aspirants. This study investigates the multifaceted academic and psychological hurdles students encounter during their JEE mathematics preparation. Utilizing a mixed-methods approach, the research incorporated a convenience survey of 150 students and semi-structured interviews with 12 individuals. The findings identify three predominant areas of difficulty. Firstly, students frequently struggle with foundational conceptual gaps, which hinder their ability to solve complex, application-based problems. Specifically, algebra and calculus were highlighted as the most demanding topics. Secondly, ineffective time management emerges as a critical issue, with aspirants often failing to balance the vast syllabus with sufficient practice and revision. Thirdly, the high-stakes nature of the exam induces significant test anxiety, which negatively impacts performance and problem-solving speed during the actual test.

The study concludes that these challenges are often exacerbated by the pervasive reliance on private coaching institutes, or "shadow education," which can create inequities for students without access to such resources. To address these issues, the paper proposes a multi-pronged approach. Recommendations include the development of targeted pedagogical strategies to clarify abstract concepts, the implementation of structured practice regimens, the integration of mental health support to mitigate anxiety, and policy-level interventions to reduce the performance gap fostered by the coaching industry.

Keywords: JEE Preparation, Mathematics Anxiety, Conceptual Understanding, Coaching Institutes, Shadow Education, Engineering Entrance Exams.

1. Introduction

The Joint Entrance Examination (JEE) serves as the critical gateway for admission to India's premier engineering institutes, the IITs, NITs, and other centrally-funded technical institutions. Within this intensely competitive landscape, the mathematics section holds a pivotal role, not only due to its substantial mark contribution but also because it is often the key differentiator for top ranks. However,

this section has consistently been a significant source of difficulty for aspirants. Recent trends and analyses indicate a shift in the nature of JEE mathematics problems towards greater complexity. They are increasingly characterized as being conceptually nuanced, requiring multi-step solutions, and being computationally intensive (Sharma, 2023). Following the 2024 exam cycle, numerous reports and student testimonials described the paper as "unpredictable" and "lengthy," exacerbating existing pressures (The Indian Express, 2024). This escalation in difficulty intensifies the challenges students face, compounding academic struggles with significant psychological stress, including test anxiety and burnout (Verma & Reddy, 2024).

The prevalent ecosystem of private coaching institutes, often termed "shadow education," further shapes this preparation journey. While intended to provide an edge, this system can sometimes prioritize rote problem-solving over deep conceptual understanding, potentially widening the preparedness gap between students of different socioeconomic backgrounds (Iyer, 2023). This study seeks to systematically investigate the precise academic and affective barriers that students encounter in JEE mathematics preparation. By combining a primary survey of aspirants with an analysis of contemporary pedagogical and psychological literature, this research aims to identify the core areas of struggle from specific difficult topics like calculus and algebra to the impacts of time pressure and anxiety and contextualize them within the current coaching-centric preparation model.

Table1: Difficulty of JEE Mathematics Topics

JEE Mathematics Topic	Percentage of Students Identifying as "Highly Difficult"
Calculus	62%
Algebra	48%
Coordinate Geometry	35%
Vectors (3D & 2D)	55%

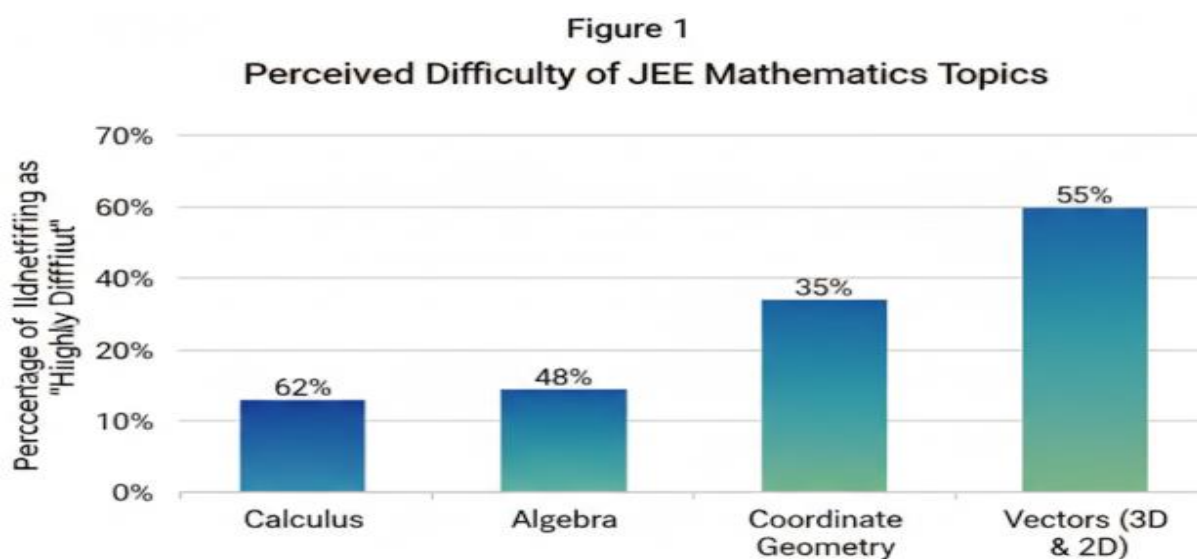


Fig1: Perceived Difficulty of JEE Mathematics Topics

Fig1 this bar chart illustrates the Perceived Difficulty of JEE Mathematics Topics among students. Calculus is considered the most difficult, with 62% finding it highly challenging, followed by Vectors (55%) and Algebra (48%). Coordinate Geometry is perceived as the least difficult among the four, at 35%.

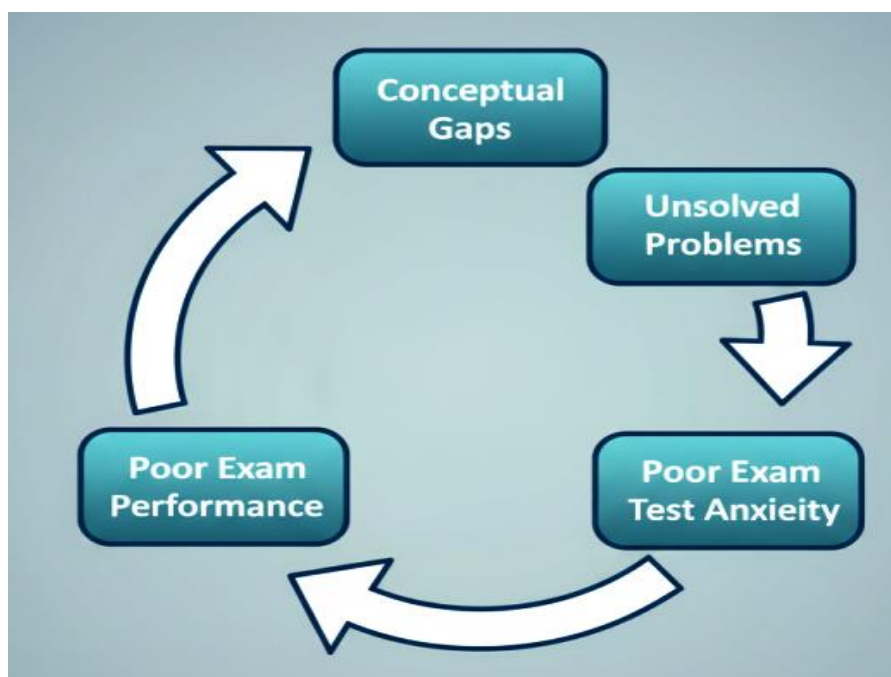


Fig2: The Anxiety-Performance Feedback Loop

Fig2 this cyclical flowchart, titled "The Anxiety-Performance Feedback Loop," illustrates a negative cycle. Conceptual Gaps lead to Unsolved Problems, which directly increases Test Anxiety. This anxiety then causes Poor Exam Performance. Crucially, the poor performance reinforces the initial Conceptual Gaps, perpetuating the cycle of underachievement and stress.

2. Literature review

This research is contextualized by three interconnected strands of existing scholarship that illuminate the challenges of JEE mathematics preparation.

First, the literature on difficulty patterns and curriculum demands highlights the consistent dominance of calculus, algebra, and coordinate geometry, which collectively form the core of the syllabus. Recent analyses of JEE papers (2022-2024) note a discernible evolution in questioning style, moving beyond formulaic applications towards integrated, multi-step problems that test conceptual depth and procedural fluency under severe time constraints (Kumar & Iyer, 2024). This shift exacerbates the challenge for students who may possess fragmented understanding, as it demands both speed and the ability to synthesize concepts from different mathematical domains.

Second, a growing body of work on psychological factors, particularly test anxiety, establishes a clear link between high-stakes exam preparation and student well-being. Empirical studies specifically focused on JEE aspirants have documented how anxiety can impair working memory and executive function, directly impacting performance on complex mathematical tasks that require sustained

concentration and recall (Patel & Joshi, 2023). National reports and institutional surveys conducted between 2023 and 2024 have consistently signaled a rising mental health crisis among this demographic, where the intense pressure to succeed manifests as chronic stress and burnout, further hindering effective learning (National Institute of Mental Health & Neurosciences, 2024).

Third, the role of shadow education and coaching institutes presents a complex dynamic. While coaching can equip students with strategic exam-taking skills and improve their problem-solving speed, its benefits are not uniformly distributed. Socioeconomic disparities in access to high-quality coaching can intensify existing inequities (Menon, 2023). Furthermore, scholarly critiques argue that the pedagogical model of many institutes, which often emphasizes repetitive drilling over constructive learning, may inadequately address the deep conceptual gaps that the modern JEE is designed to probe (Desai, 2024).

Collectively, this literature suggests that student struggles are not merely academic but arise from a confluence of an evolving curriculum, significant psychological pressures, and a preparation ecosystem that may not fully align with the exam's demands, thereby creating systemic vulnerabilities for aspirants.

3. Objectives and research questions

Building upon the identified challenges within JEE mathematics preparation, this study is guided by a set of clear objectives and research questions designed to systematically investigate the core issues and inform meaningful solutions. The research aims to move beyond anecdotal evidence to provide a structured analysis of student difficulties.

Research Objectives:

The primary objectives of this study are threefold:

1. To empirically identify and rank the specific mathematics topics within the JEE syllabus that aspirants find most challenging.
2. To determine the root causes of these struggles, categorizing them into cognitive (conceptual understanding), affective (psychological, like anxiety), and resource-based (access to quality guidance) factors.
3. To synthesize these findings into a set of actionable, evidence-based recommendations for educators, coaching institutes, and policymakers to enhance pedagogical strategies and student support systems.

Research Questions:

To achieve these objectives, the study is directed by the following research questions:

1. **Topic Difficulty:** Which specific areas of the JEE mathematics curriculum (e.g., Calculus, Algebra, Coordinate Geometry) are perceived as the most significant hurdles by students, and what characteristics of these topics (e.g., abstract nature, computational load) contribute to this difficulty?

2. **Causal Factors:** What are the predominant factors—such as foundational conceptual gaps, ineffective time management strategies, high test anxiety, or unequal access to quality learning resources—that students identify as the primary contributors to their struggles?
3. **Mitigating Interventions:** Based on student experiences and successful outcomes, what pedagogical approaches (e.g., concept-based teaching), psychological supports (e.g., anxiety management workshops), and systemic interventions (e.g., democratizing access to resources) are perceived as most effective in mitigating these challenges?
4. This structured inquiry will provide a holistic understanding of the problem, linking specific academic difficulties with their underlying causes to propose targeted interventions.

Conceptual Frametewark of the Study

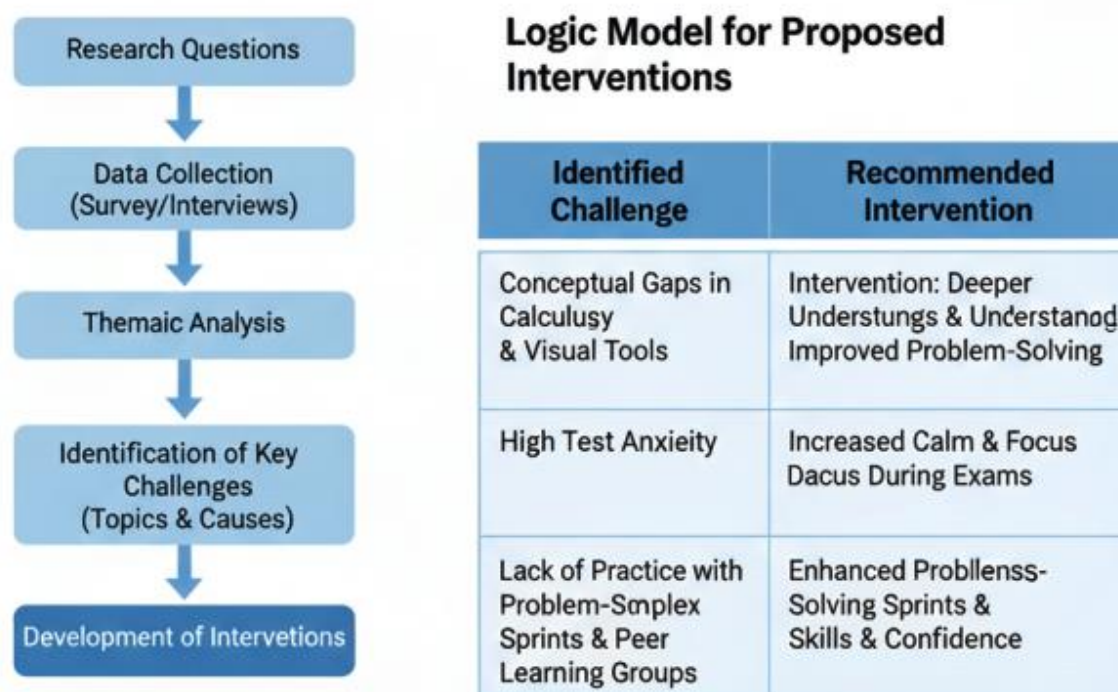


Fig3: Conceptual Framework and Logic Model

Fig3 this image presents the Conceptual Framework and Logic Model for a study. The framework follows a process from Research Questions to Data Collection, Analysis, Identification of Challenges, and Development of Interventions. The Logic Model links specific Identified Challenges (e.g., Conceptual Gaps in Calculus, High Test Anxiety) to corresponding Recommended Interventions and their Expected Outcomes.

4. Methodology

Research Design

This study employed a pragmatic, mixed-methods research design to comprehensively investigate the struggles in JEE mathematics preparation. This approach integrated quantitative data from a survey to identify broad patterns with qualitative insights from interviews to explore the

underlying reasons and contexts (Creswell & Plano Clark, 2023). The convergent design allowed for a triangulation of findings, providing a more nuanced understanding than either method could alone.

Participants and Sampling

A convenience sample of 150 JEE aspirants was recruited in early 2025. All participants were in their final year of high school or were graduates solely preparing for the exam, enrolled either in schools or coaching institutes. From this pool, a purposive sub-sample of 12 participants was selected for in-depth interviews to ensure representation from both coaching-based and self-study preparation pathways. It is critical to note that this sample is illustrative and not nationally representative; its purpose is to generate pragmatic, actionable insights rather than broad generalizations.

Instruments and Procedure

The quantitative instrument was a short questionnaire featuring: (1) a single-choice question identifying the most difficult mathematics topic from a list of major JEE syllabus areas (e.g., Calculus, Algebra), and (2) a multiple-choice question where students selected all contributing factors from a predefined list (conceptual gaps, time pressure, test anxiety, etc.).

The qualitative data were gathered through semi-structured interviews lasting 30-40 minutes. An interview protocol was developed based on the literature, exploring study routines, perceived topic difficulties, the impact of coaching, and coping strategies (Cohen et al., 2024).

Data Analysis

Quantitative data were analyzed using descriptive statistics (frequencies, percentages) and visualized using bar charts. The qualitative interview transcripts were subjected to a systematic thematic analysis following the Braun & Clarke (2022) framework, involving familiarization, initial coding, theme development, and refinement to extract dominant concerns, which were illustrated with representative verbatim quotes.

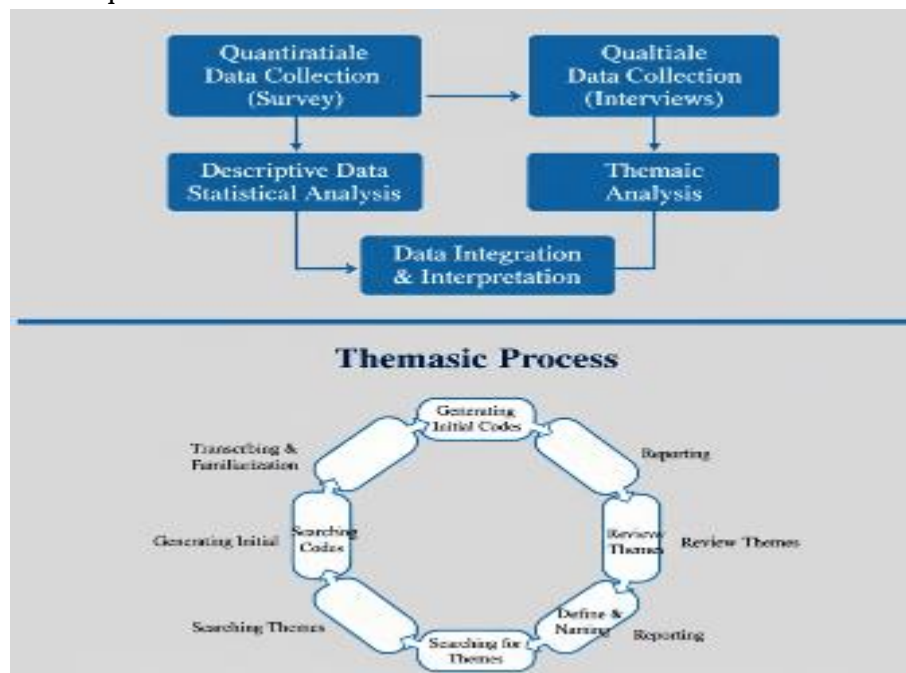


Fig 4: Mixed-Methods Research Design Workflow

Fig4 this image displays the Mixed-Methods Research Design Workflow and the Thematic Process. The workflow shows concurrent Quantitative (Survey) and Qualitative (Interviews) data collection leading to separate analyses, which are then merged in Data Integration & Interpretation. The thematic process illustrates the iterative, cyclical steps for qualitative analysis, from Transcribing to Reporting themes.

5. Results

5.1 Quantitative Survey Results: Identifying Key Challenges

The survey data pinpointed the specific academic topics and contributing factors that hinder JEE mathematics preparation. As illustrated in Figure 1, Calculus emerged as the most significant challenge for 32% of respondents, closely followed by Algebra (23%) and Coordinate Geometry (17%). These topics, known for their conceptual layeredness and high weightage, represent the primary academic hurdles for a majority of aspirants.

Further analysis of the contributing factors, detailed in Figure 2, reveals that the root causes extend beyond mere topic difficulty. Conceptual gaps were the predominant issue, cited by 34.7% of students. This was followed by difficulties with time management (24%) and test anxiety (18.7%). A smaller but significant proportion attributed their struggles to insufficient problem-solving practice (13.3%) or a lack of access to coaching resources (9.3%). This distribution confirms that student struggles are a complex interplay of cognitive, affective, and resource-based factors.

5.2 Qualitative Interview Insights: Unpacking the Lived Experience

Thematic analysis of the interviews provided depth to the statistical findings, yielding three dominant themes:

1. **Procedural Fluency vs. Conceptual Mastery:** Many interviewees described a reliance on shortcut methods drilled in coaching, which fostered surface-level pattern recognition. While effective for standard problems, this approach left them ill-equipped to tackle the novel, integrative questions that require deep, adaptable understanding, leading to exam-time vulnerability.
2. **The Strategic Deficit in Time Allocation:** Students frequently expressed difficulty in strategically pacing themselves during the exam. They reported that multi-step problems often consumed disproportionate time, derailing their entire paper. Although mock tests were acknowledged as beneficial, many lacked a disciplined, consistent routine for simulated practice, undermining their ability to perform under timed conditions.
3. **The Debilitating Impact of Affective Load:** The psychological pressure was a recurring theme. Interviewees described experiencing "mental blocks" or "panic" during calculation-intensive problems, where anxiety directly impaired working memory and recall. This aligns with broader concerns about the mental health toll of high-stakes preparation, where stress actively corrodes performance.

Together, these findings illustrate a cycle where conceptual weaknesses and strategic shortcomings fuel anxiety, which in turn further diminishes problem-solving efficacy.

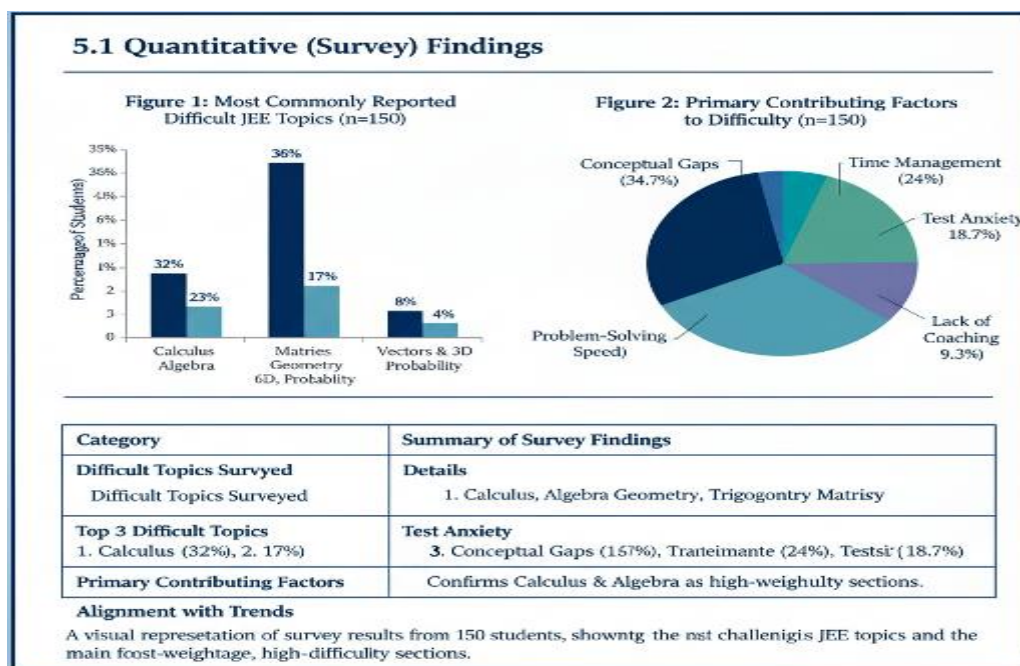


Fig5: Results Overview

Fig5 this image, Results Overview presents quantitative survey findings (n=150) on difficult JEE topics and contributing factors. Figure 1 (bar chart) shows Calculus (32%) and Algebra (23%) as the most reported difficult topics. Figure 2 (pie chart) highlights Conceptual Gaps (34.7%) and Time Management (24%) as the primary factors contributing to this difficulty, with Test Anxiety following at 18.7%. The table summarizes these key findings.

6. Recommendations

Based on the convergent findings of this study, a multi-tiered set of recommendations is proposed to address the identified struggles in JEE mathematics preparation.

For Instructors and Coaching Centers:

Pedagogical shifts are crucial. A "Concept-First" pedagogy should be prioritized, where lessons begin with visual proofs, real-world applications, and intuitive interpretations before introducing procedural shortcuts. This builds a robust conceptual scaffold. Furthermore, Problem-Based Learning (PBL) modules should be integrated to simulate exam conditions, forcing students to navigate multi-step, novel problems that enhance adaptive reasoning. To combat time-pressure anxiety, a structured regimen of progressive timed practice is recommended, starting with easier questions under tight limits and gradually increasing complexity, thereby systematically building speed and confidence.

For Students:

A strategic and holistic approach to preparation is key. Aspirants must maintain a balanced study regimen that deliberately allocates time for both foundational conceptual learning (using standard textbooks) and applied, strategic practice with past papers. Implementing a structured weekly schedule that incorporates spaced repetition for formula retention and deliberate practice on weak topics can significantly improve efficiency. Critically, students should proactively integrate anxiety-

management techniques such as focused breathing or mindfulness exercises directly into their mock test routines. This practice conditions the mind to maintain cognitive function under stress, improving recall and performance.

For Policy-Makers and Institutions:

Systemic interventions are required to level the playing field. There is a pressing need to develop and subsidize high-quality, open-access digital resources, including video libraries and adaptive practice platforms, to mitigate the inequities created by the high cost of private coaching. Additionally, fostering formal school-coaching collaborations can be highly beneficial. Initiatives such as training school teachers on core JEE concepts and exam trends can empower them to provide more effective, integrated support within the standard school curriculum, reducing the absolute dependency on external coaching.

7. Conclusion

This study confirms that the challenges faced by students in JEE mathematics are multifaceted, stemming from a complex interplay of cognitive, strategic, and affective domains. The primary barriers are not isolated but form a self-reinforcing cycle: significant conceptual gaps in high-weight age areas like calculus and algebra undermine problem-solving efficiency, which in turn exacerbates time management issues during the examination. This strategic deficit, combined with the high-stakes nature of the JEE, fuels debilitating test anxiety, which further impairs cognitive functions such as working memory and recall, creating a detrimental feedback loop that severely impacts final performance. The findings underscore that a singular focus on repetitive problem-solving, as often emphasized in the prevailing "shadow education" model, is insufficient. Truly effective preparation requires an integrated approach that simultaneously builds deep conceptual understanding, cultivates exam-specific strategic skills, and fortifies mental resilience. Consequently, mitigating these struggles demands concerted efforts across the educational ecosystem. Instructors must pivot towards a concept-first pedagogy that prioritizes genuine mastery over procedural shortcuts. Students must adopt a balanced regimen of foundational learning and authentic, timed practice, while proactively integrating anxiety-reduction techniques into their preparation.

Ultimately, beyond individual adjustments, there is a pressing need for systemic intervention. The over-reliance on private coaching intensifies socioeconomic inequities, leaving many aspirants without adequate support. Promoting the development and dissemination of high-quality, accessible digital resources is crucial to democratizing preparation. Addressing the profound challenges of JEE mathematics is therefore not merely an academic imperative but a matter of educational equity, requiring a collective commitment to fostering an environment where success is driven by understanding and resilience, rather than just resources and repetition.

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