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# MATHEMATICS LEARNING DIFFICULTIES AMONG UNDERGRADUATE STUDENTS: A COMPARATIVE STUDY

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**Abstract:** Mathematics is a fundamental component of undergraduate education, particularly in science, technology, engineering, commerce, economics, and computer-related disciplines. Despite its importance, many undergraduate students experience persistent difficulties in understanding mathematical concepts, applying formulas, interpreting problems, and developing systematic problem-solving strategies. These difficulties may arise from weak prerequisite knowledge, mathematics anxiety, ineffective study habits, language-related barriers, limited conceptual understanding, and differences in instructional approaches. This study presents a comparative analysis of mathematics learning difficulties among undergraduate students from different academic backgrounds. The study proposes a descriptive research framework based on selected indicators, including conceptual understanding, algebraic manipulation, problem-solving ability, mathematical anxiety, learning motivation, use of technology, and prerequisite knowledge. An illustrative comparative dataset is used to demonstrate the analytical procedure. The findings indicate that students with stronger mathematical foundations generally demonstrate better conceptual understanding and problem-solving performance, while students with weaker prerequisite knowledge exhibit greater difficulty in algebra, calculus, and mathematical modeling. Mathematics anxiety is also associated with reduced confidence and lower participation. The study emphasizes the importance of diagnostic assessment, conceptual teaching, active learning, academic support, and appropriate use of digital mathematical tools. The findings suggest that learning difficulties should not be treated as permanent deficiencies; instead, targeted pedagogical interventions can substantially improve undergraduate mathematics learning outcomes.

**Keywords:** Mathematics Learning Difficulties, Undergraduate Students, Mathematics Anxiety, Conceptual Understanding, Problem Solving, Higher Education, Mathematics Education, Learning Outcomes.

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## 1. Introduction

Mathematics plays a central role in higher education because it provides the theoretical and computational foundation for numerous academic disciplines. Calculus, algebra, statistics, differential equations, discrete mathematics, probability, and numerical methods are incorporated into undergraduate programs such as engineering, computer science, physics, economics, commerce, and management. Mathematical competence therefore contributes significantly to students' academic progression and professional development.

However, mathematics is frequently perceived by undergraduate students as one of the more difficult areas of study. Students may successfully memorize formulas but struggle to understand the underlying concepts or apply mathematical principles to unfamiliar problems. A student may, for example, know the formula for differentiation but fail to recognize when or why a particular differentiation technique should be applied. Similar difficulties occur in integration, matrix operations, probability, differential equations, and mathematical modeling.

Mathematics learning difficulties are multidimensional. They cannot be attributed solely to students' intellectual ability. Previous educational research indicates that prior mathematical knowledge, instructional methods, motivation, learning environment, anxiety, self-efficacy, and study habits can influence mathematical achievement.

Undergraduate students also enter higher education with substantially different educational backgrounds. Some students have studied mathematics intensively at the secondary and higher-secondary levels, while others may have had limited exposure to advanced mathematical concepts. Consequently, students entering the same university course may possess significantly different levels of prerequisite knowledge.

The rapid growth of educational technology has introduced another dimension to mathematics learning. Computer algebra systems, mathematical visualization software, online lectures, interactive simulations, and artificial intelligence-based learning systems can provide additional support. However, technology cannot automatically overcome conceptual gaps. Effective integration requires appropriate pedagogical design and student guidance.

This study therefore examines mathematics learning difficulties among undergraduate students from a comparative perspective and identifies major

academic, psychological, and instructional factors associated with these difficulties.

**2. Objectives of the Study**

The major objectives are:

- To identify common mathematics learning difficulties among undergraduate students.
- To compare mathematical performance across different academic backgrounds.
- To examine the influence of prerequisite knowledge on mathematics achievement.
- To analyze the role of mathematics anxiety and learning motivation.
- To identify effective strategies for reducing mathematics learning difficulties.
- To propose an intervention framework for undergraduate mathematics education.

**3. Literature Review**

Mathematics learning is a complex cognitive process involving conceptual understanding, procedural knowledge, logical reasoning, representation, and problem solving. Students frequently experience difficulty when they rely primarily on memorization rather than understanding mathematical relationships.

One major factor influencing undergraduate mathematics performance is prerequisite knowledge. Higher-level mathematics is cumulative: concepts introduced in algebra and trigonometry are required for calculus, while calculus concepts may subsequently be required for differential equations and engineering mathematics. A weakness at an earlier stage can therefore create difficulties in later courses.

Another important factor is mathematics anxiety. Students who associate mathematics with fear of failure may avoid mathematical tasks, participate less frequently in class, and experience reduced confidence. Anxiety can create a negative cycle in which avoidance reduces practice, insufficient practice reduces achievement, and poor achievement further increases anxiety.

Problem-solving ability is another significant challenge. Students often demonstrate competence when solving routine textbook exercises but experience difficulty with unfamiliar or application-oriented problems. This suggests that procedural knowledge does not necessarily guarantee conceptual understanding.

Learning difficulties may also be influenced by instructional practices. Highly lecture-centered instruction can provide efficient content delivery but may offer insufficient opportunities for students to explore mathematical ideas, discuss alternative solution strategies, and receive formative feedback. Active learning, collaborative problem solving, visualization, and contextualized examples can provide additional opportunities for conceptual development.

Digital mathematical tools can support learning by enabling students to visualize functions, manipulate parameters, verify calculations, and explore mathematical models. However, students need adequate mathematical understanding to interpret computational results correctly.

**4. Research Methodology**

**4.1 Research Design**

The study adopts a **comparative descriptive research design**. Undergraduate students are conceptually divided into groups according to academic background and previous mathematics preparation.

For an empirical implementation, a sample of approximately 150–300 undergraduate students could be selected from science, engineering, commerce, and computer-related programs.

**4.2 Research Instruments**

A structured questionnaire and mathematics achievement test may be used.

The questionnaire can measure:

- Mathematics anxiety
- Learning motivation
- Study habits
- Self-confidence
- Technology usage
- Perceived difficulty

The achievement test can assess:

- Algebra
- Calculus
- Geometry
- Statistics
- Problem solving
- Mathematical reasoning

**5. Major Mathematics Learning Difficulties**

**5.1 Weak Prerequisite Knowledge**

One of the most significant difficulties is insufficient knowledge of fundamental mathematics. Students may enter undergraduate programs without adequate understanding of fractions, algebraic manipulation, logarithms, trigonometry, equations, and functions.

For example, solving

$$\frac{2x+3}{5}=7$$

requires basic algebraic manipulation. A student with weak algebraic foundations may struggle with this relatively simple equation and subsequently face greater difficulties when algebra is embedded within calculus or differential equations.

### 5.2 Difficulty in Understanding Abstract Concepts

Undergraduate mathematics frequently involves abstraction. Concepts such as limits, continuity, vector spaces, eigenvalues, convergence, and differential equations cannot always be understood through memorization.

For example, the derivative

$$f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h}$$

requires students to understand the conceptual relationship between limits, change, and slope rather than simply memorize differentiation formulas.

### 5.3 Algebraic Manipulation Problems

Algebra serves as the language of advanced mathematics. Students who experience difficulty with factorization, equations, indices, logarithms, functions, and symbolic manipulation may struggle across several undergraduate mathematics courses.

### 5.4 Calculus Difficulties

Calculus represents a major transition from school-level mathematics to university mathematics. Students often experience difficulties understanding limits, derivatives, integrals, and their applications.

A common issue is treating differentiation and integration as collections of formulas rather than connected mathematical concepts.

### 5.5 Problem-Solving Difficulties

Students may correctly perform computational procedures but fail to identify appropriate solution strategies for unfamiliar problems.

Effective mathematical problem solving generally involves:

**Understanding → Planning → Mathematical Representation → Calculation → Verification**

Failure at any stage can result in an incorrect solution.

## 6. Comparative Analysis

To demonstrate the proposed analytical framework, Table 1 presents an **illustrative dataset**.

**Table 1. Illustrative Mathematics Performance by Academic Background**

| Academic Group | Mean Achievement (%) | Conceptual Understanding | Problem Solving | Anxiety Level |
|---|---|---|---|---|
| Engineering | 76 | 4.1 | 4.0 | 2.8 |
| Science | 79 | 4.3 | 4.2 | 2.5 |
| Computer Science | 72 | 3.8 | 3.9 | 3.0 |
| Commerce/Management | 64 | 3.4 | 3.2 | 3.6 |

Scores for conceptual understanding, problem solving, and anxiety are illustrative five-point ratings.

The illustrative results suggest that students with stronger prior mathematical exposure may achieve higher mathematics scores. Science and engineering students demonstrate relatively strong conceptual and problem-solving performance, whereas students with less intensive mathematical preparation may require additional academic support.

## 7. Mathematics Anxiety and Learning Outcomes

Mathematics anxiety can be represented using a five-point scale, where a higher value indicates greater anxiety.

**Table 2. Illustrative Relationship Between Anxiety and Achievement**

| Anxiety Level | Mean Achievement (%) |
|---|---|
| Low | 82 |
| Moderate | 74 |
| High | 63 |
| Very High | 55 |

## 8. Discussion

The comparative framework indicates that mathematics learning difficulties result from interactions among academic, psychological, and instructional factors. Students with weak prerequisite knowledge are particularly vulnerable because undergraduate mathematics builds upon previously learned concepts.

The transition from procedural school mathematics to conceptually oriented university mathematics may also contribute to learning difficulties. Students who previously depended heavily on memorization may struggle when university courses require proof, abstraction, mathematical modeling, and independent reasoning.

Mathematics anxiety represents another important issue. Students experiencing anxiety may avoid participation and practice, thereby limiting opportunities to develop mathematical competence. Supportive classroom environments, constructive feedback, low-stakes assessments, and opportunities for repeated practice can help reduce this problem.

Technology can provide additional support through interactive visualization and personalized learning. Nevertheless, technology should supplement rather than replace mathematical reasoning. Students

should be encouraged to explain computational results and justify their solution strategies.

**9. Recommended Intervention Framework**

A comprehensive intervention strategy should include the following stages:

**Stage 1: Diagnostic Assessment**

Students should complete a prerequisite mathematics assessment at the beginning of the academic year.

**Stage 2: Identification of Learning Gaps**

Individual weaknesses should be categorized into algebra, calculus, geometry, statistics, or problem-solving domains.

**Stage 3: Targeted Remediation**

Short supplementary modules should address identified deficiencies.

**Stage 4: Active Mathematical Learning**

Teachers should incorporate:

- Group problem solving
- Mathematical discussions
- Concept mapping
- Real-world applications
- Peer instruction
- Interactive demonstrations

**Stage 5: Digital Support**

Students can use appropriate mathematical software and online resources for additional practice and visualization.

**Stage 6: Continuous Assessment**

Frequent formative assessments should be used to monitor progress.

**10. Conclusion**

Mathematics learning difficulties among undergraduate students are complex and cannot be explained by a single factor. Weak prerequisite knowledge, difficulties with abstraction, algebraic errors, calculus misconceptions, inadequate problem-solving strategies, mathematics anxiety, low motivation, and ineffective study practices may interact to influence learning outcomes.

The comparative framework presented in this study indicates that students with stronger mathematical foundations generally have greater conceptual understanding and problem-solving ability. Students with limited prior preparation require additional support during the transition to university mathematics.

Mathematics anxiety is another important concern because negative emotional responses can reduce confidence and participation. Universities should therefore treat mathematics learning as both a cognitive and affective process.

A combination of diagnostic testing, remedial instruction, active learning, formative assessment, mathematical visualization, peer support, and appropriate digital technologies can provide an effective intervention strategy.

Future empirical research should use larger and more diverse samples and apply statistical techniques such as t-tests, ANOVA, regression analysis, and structural equation modeling to examine relationships among prerequisite knowledge, anxiety, motivation, instructional practices, and mathematics achievement.

Ultimately, mathematics learning difficulties should not be viewed as fixed characteristics of students. With appropriate instructional support and carefully designed learning environments, undergraduate students can develop stronger mathematical competence, confidence, and problem-solving skills.

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