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Voices from the Mathematics Classroom: Insights from an Inquiry into Student Challenges

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Abstract:

This research paper tries to look into the challenges encountered by school students at secondary level in learning Mathematical concepts. Through a comprehensive analysis, the challenges that hinder students' progress in mastering mathematical concepts have been identified and examined. This study has been conducted on students from the secondary classes of classes 9 and 10. It aims to provide valuable insights into the nature of the challenges faced by students through semi structured interviews, Likert scale analysis and focused group discussions. The data collected through each tool was analysed and themes were drawn. It proposes effective strategies and interventions to help students overcome these mathematical challenges and in creating a more inclusive and supportive learning environment at secondary level.

Key Words: Mathematics Education, Mathematical challenges, Pedagogical Practices.

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Introduction:

Education serves as the basic backbone of nation building and development. It is an important instrument that can help in generating knowledge, skills, and awareness among students. Currently, India is moving forward on the path of development and intends to become a developed nation by 2047. Inclusion of 21st century skills in education is vital in achieving the above-stated goal. Mathematics plays a significant role in developing logical reasoning and problem solving skills. Mathematical knowledge is important in handling transactions involving money, technology, and data.

In the history of India, Mathematics has always had great importance with notable contributions from Indian mathematicians such as Aryabhata, Brahmagupta, and Bhaskaracharya who had an impact on contemporary mathematics not only in India but at the world level. In this regard, the educational system of India, which is characterized by various policies, attempts to nurture this mathematical heritage by keeping pace with the ever-changing world.

Over the years, several Indian Education Policies have addressed the role of mathematics education. The National Policy on Education, 1986, highlighted the importance of mathematics in the school curriculum, for providing a stronger foundation in the subject to all students. The Plan of Action 1992 stressed the significance of mathematics as an essential subject within the school curriculum. The Plan also stressed the need for encouraging mathematical teaching with a special emphasis on the comprehension of concepts and problem solving abilities. In addition, the application-oriented nature of mathematics was also appreciated. The NCF 2005 introduced significant changes in the way mathematics was taught in schools. It advocated for a shift from rote learning to child-centric and activity-based approach. It emphasized the importance of mathematical thinking, reasoning, and problem-solving. The framework also suggested the integration of mathematics with real-life situations and other subjects.

Recently, the National Education Policy (NEP 2020) has suggested significant changes in the educational arena of Mathematics. It envisions a holistic, multidisciplinary, experiential approach to learning the subject. Importance has been given to Indian Knowledge System, emphasizing the development of mathematical thinking and problem-solving skills from an early age. The National Education Policy (NEP 2020) further led to formulation of two specific curricular frameworks NCF-FS(2022) for foundational Stage and NCFSE (2023) for School Education. Emphasis was given on encouraging critical thinking and mathematical reasoning from an early age, reducing the curriculum load to focus on essential topics and promoting a multidisciplinary approach, introducing coding and computational thinking as part of mathematics education, strengthening teacher training to enhance the quality of mathematics instruction, providing flexibility in choosing mathematics courses, allowing students to pursue different levels of mathematics based on their interests and career goals.

All these things are being done because the situation regarding mathematics education in India consists of a myriad of obstacles as well as prospects. Having qualified math tutors, having difficulties in accessing web-based information due to the digital divide, and the necessity to clear various competitive examinations are some of the mathematical hurdles students have to overcome.

This paper seeks to explore such mathematical hurdles that often regress the process of learning and teaching mathematics in India. Through a careful analysis of the current policies and their future implications, we seek to find ways of overcoming these hurdles and developing an effective mathematics education environment in India.

Review of literature

Jean Piaget (1970) described the stages of cognitive development, and in his theory of cognitive development, he explained that abstract reasoning develops in formal operational thinking. In the learning of advanced mathematical concepts at the secondary level, students are required to exhibit

hypothetical thinking which cannot be expected from all young students at this stage. Therefore, a comprehensive understanding of abstract concepts may take time to develop at this stage. Similarly, Carolyn Kieran (1992) highlighted that students generally face difficulties understanding algebraic relationships because they often emphasise the application of rules, which may lead to difficulty with symbolic representation. Therefore, Kieran highlighted that a relational understanding of algebra is necessary for students to interpret and use symbolic representations meaningfully. Kenneth Ruthven and Sara Hennessy (2002) examined the role of digital technologies in mathematics education and highlighted the significance of digital technologies in the conceptual understanding of students. They suggested that in comparison to traditional methods, interactive tools can support learning in a much better way to understand the abstract concept. Through digital technologies more senses can be involved which ultimately leads to active engagement of students. They also highlighted that technology alone cannot yield positive results; it depends on how a teacher integrates these technological tools into their teaching. This study underscored the importance of meaningful interaction and transformation in pedagogical approaches, which leads to meaningful mathematical learning.

The idea of a "growth mindset" was presented by Carol Dweck (2006). As per the idea, the students who are growth-oriented view their mistakes as learning opportunities. Moreover, according to the theory, intelligence and abilities can be improved by making constant efforts. In the context of teaching mathematics, a growth mindset helps students become more involved in solving problems instead of avoiding them. The belief held by students about their capabilities has a strong bearing on their motivation, performance, and approach towards mathematics problems. James Kaput (2008) focused on the progression of algebraic thinking and explored the issues related to the expansion and transition from arithmetic to algebra. According to Kaput, students frequently faced issues when they have to move from concrete to abstract concepts in Mathematics. He indicated that abstract reasoning related to algebra needs to be introduced in more simplified manner and should be distributed in all levels of school education rather than introduction at

specific level of understanding of Mathematics. His work highlighted the importance of providing of opportunities to students to explore with symbolic representation to students from their early school life. John Hattie (2009), in a comprehensive study of factors that contribute to student achievement, found that these factors have a substantial impact on student achievement. His findings highlighted that the teacher's role is crucial to improve the learning outcomes. Timely feedback and continuous evaluation help identify learning gaps and improve students' performance. According to Alan Schoenfeld (2011), effective learning in the field of mathematics will become more possible when such learning involves reasoning-based problems. The research findings indicated that knowledge of skills and facts does not guarantee the attainment of a thorough comprehension of mathematics. In addition, it was also noted that effective mathematics learning is characterized by the process of regulating and evaluating one's thoughts using metacognition as opposed to simple memorization. In this regard, learning in mathematics should provide students with chances of acquiring conceptual comprehension and problem-solving skills.

Jo Boaler (2016) has highlighted the significance of psychological factors in learning mathematics. Her work emphasizes that children harbor various apprehensions regarding the subject. A student's performance in mathematics depends on several psychological factors—such as the fear of failure, self-doubt regarding one's abilities, and the nature of the educational experiences encountered within the classroom. According to Boaler, it is essential to cultivate a conducive learning environment for mathematics education, enabling students to learn through open-ended exercises and overcome their internalized fears. Street, Malmberg, and Schukajlow (2024) reviewed 49 studies published between 2018 and 2022 on students' mathematics self-efficacy. The review explores that mathematics self-efficacy is closely linked to students' motivation, engagement, achievement, perseverance, and career aspirations. Those students engaged more in activities related to mathematics who have confidence in their abilities and have less anxiety about mathematics. This review also identifies teacher support, positive learning experiences, peer relationships, and opportunities as key factors in fostering students' confidence

in mathematics. It is also concluded that mathematics self-efficacy plays a significant role in shaping students' success in mathematics.

Purpose of the study

The primary objective of this research is to analyse of the challenges faced by secondary school students delimited to class 9 and 10 in mathematics. By identifying these challenges, we aim to provide the stake holders a deeper understanding in order to improve the overall quality of mathematics education. Through empirical evidence and understanding of the issues, this paper aspires to contribute for the enhancement of students' mathematical learning experiences.

Research questions

To guide our investigation, this study seeks answers to the following key questions:

- What are the most common challenges encountered by school students in learning mathematics at secondary level (classes 9-10)?
- Which Areas/topics do the students find most difficult in secondary level (classes 9-10) mathematics?
- What strategies and interventions can prove effective for the specific challenges faced by secondary level (classes 9-10) students in Mathematics?

Objectives

- To identify the challenges faced by Secondary level students (Class 9 and 10) in learning mathematical concepts.
- To study the factors contributing to students' Secondary level students (Class 9 and 10) challenges in learning mathematical concepts.
- To suggest strategies for overcoming the identified challenges in learning mathematical concepts.

Research methodology

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This study was carried out using mixed method research design in order to explore the challenges faced by students in learning mathematical concepts at secondary level. To ensure diverse representation of students, the sample of 62 students from grade 9 and 10 of different schools of Delhi NCR were taken by using purposive sampling. Only those students of class 9 and 10 were considered as sample, who faced difficulty in learning mathematical concepts.

The data from the students was collected through-

- Semi structured interview
- Likert scale
- Focused Group Discussions

Analysis and findings

The data was collected from the students of class 9 and 10 students and was analysed. The details of the analysis and the corresponding findings are as given below:

Personal Experiences and Attitudes

Semi-Structured interviews were conducted with students to identify their struggles in learning mathematical concepts. The qualitative data obtained from semi-structured interviews were analysed using thematic analysis. The collected data were analysed to derive initial codes, which were further grouped into major themes on the basis of similar contexts.

Rich qualitative data on students' personal experiences, attitudes, and perceptions regarding mathematical challenges could be gathered through the interviews. Themes such as fear of failure, negative self-perception, adverse effect of peer pressure and the influence of supportive learning environment emerged as recurring factors contributing to students' struggles.

Excerpts from interviews are presented in Table 1, along with initial codes and themes.

Table 1 Themes drawn out from Semi- Structured Interviews with Students

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Excerpt	Initial codes	Theme
"I always worry about getting things wrong. It "If I don't get a concept quickly, I feel like a failure. It's like everyone else gets it, but I'm just lost."	Fear of Failure Committing Mistakes Anxiety	Fear of Failure
"I feel like I'm just not good at math. No matter how much I study, it never clicks."	Lack of Self-Efficacy Perceived Inability	Negative Self Perception
"When my friends say they find math easy, I feel like I'm the only one struggling. It's discouraging."	Influence of Peers Comparison	Adverse effect of peer pressure
"A supportive teacher makes a huge difference. If I feel comfortable asking questions, I learn better."	Teacher-Student Dynamics Encouragement Support	Supportive Learning Environment

Perceived Difficulty Levels

A 5 point Likert scale for determining the perceived difficulty levels for various mathematical concepts was distributed to a sample of 62 students from 9th and 10th classes. The responses obtained from the Likert-scale indicated variations in perceived difficulty, with certain topics consistently posing greater challenges than others in mathematics.

Table 2: Difficulties faced by students in specific topics/areas

Mathematical Concept	Mean	Standard Deviation	Key Insights
Algebra	4.2	0.78	• Commonly identified as a significant challenge • Higher average difficulty compared to other concepts

Geometry	4.0	0.72	• Notable difficulty reported, though slightly lower than algebra • Spatial visualisation and problem-solving aspects highlighted
Arithmetic	2.8	1.12	• Relatively lower perceived difficulty, but notable variation • Some variability in difficulty levels among specific operations
Statistics and Probability	3.2	0.95	• Generally perceived as less challenging • Challenges in interpreting statistical data discussed

Through this data it can be interpreted that Algebra has been identified as the most challenging area with mean of 4.2. Mathematical concepts under Geometry were also found to be challenging, students reported slightly lower difficulty as compared to algebra. Spatial visualization and problem-solving aspects were highlighted as a bigger challenge by the students. Arithmetic was generally perceived as less challenging (2.8). It was also found that Statistics and Probability were perceived to be relatively less difficult with notable variation.

The variability score through Standard deviation provides an insight into the distribution of responses. Higher Standard deviation in arithmetic shows varied levels of difficulties amongst the learners. Whereas, in Algebra and Geometry, variability towards the difficulty level was consistent that means majority of the students had similar perception towards the difficulty level. However, the concepts of Statistics and Probability exhibited moderate variability, reflecting differences in students' ability to interpret statistical concepts.

Focused Group Discussion

The focus group discussions were conducted in order to collect voices or insights of the students, fostering open conversations about their mutual experiences in mathematics classrooms and beyond. Common patterns and trends emerged, revealing collaborative strategies employed

by students to overcome challenges. The discussions also unveiled latent issues, such as peer competition and societal expectations, influencing students' perceptions of mathematical proficiency.

The themes drawn out from the focus group discussions are summarised in the Table 3 given below:

Table 3 Themes from Focus Group Discussions

Themes from Focus Group Discussions	Description
Communal Nature of Challenges	Participants acknowledged that many mathematical challenges were shared among the group.
Collaborative Strategies	Students reported using collaborative learning methods, like group study sessions, to tackle challenges.
Peer Competition	The discussions highlighted an undercurrent of peer competition, influencing students' attitudes towards mathematics
Societal Expectations	Participants expressed feeling the weight of societal expectations regarding mathematical proficiency.
Influence on Perceptions	The latent issues of peer competition and societal expectations were identified as influencing students' perceptions of their own mathematical abilities.
Potential for Collaborative Solutions	The focus groups emphasised the potential for collaborative solutions to address shared challenges and foster a positive learning environment.

The exploration of barriers to learning mathematics faced by students, as identified by teachers and from the research itself, underscores the multifaceted challenges inherent in the educational landscape. From a lack of conceptual understanding to societal attitudes and resource limitations, the barriers are interconnected and require a comprehensive approach to foster meaningful change.

Recommendations

On the basis of the analysis following recommendations have been suggested

- Providing more support for Algebra at Secondary level: Using the tools of visualization such as Geogebra, Desmos etc. and use of manipulatives such as board games to uncover the algebraic relations. Remedial sessions or tutorials for applicability of algebra to real life using problem solving for children facing specific learning or conceptual difficulties.
- Developing Problem Posing Amongst Learners: In mathematics classrooms the learners to be encouraged to pose or frame problems for their meaningful engagement.
- Promoting Positive Mathematics Classrooms: Challenge societal attitudes such as fear for mathematics and stereotypes such as boys are better in mathematics than girls or vice-versa. Promote a positive and growth-oriented mindset among students with healthy competition.
- Modification in Assessment Practices: Assessment needs to be shifted from procedural to conceptual, so that rote memorization could be curbed. Also, there is need for differentiated assessments as well as assignments as per the specific needs and preparedness of the learners.
- Removing the Language Barrier: In learning of Mathematics the emphasis should be on Mathematical language as any other language or dialect is just a means to understand the concept not a barrier and, in this direction, suitable support to be provided to the learners.
- Class Size Reduction Strategies: Explore strategies to reduce class sizes or implement alternative instructional methods that cater to the diverse learning needs of students in larger classrooms especially for mathematics learning.

Conclusion

It can be concluded that this paper, provides a detailed analysis of the challenges faced by students studying mathematics in classes 9 and 10 of secondary level. The recommendations presented in the paper would help students, teachers and administrators in overcoming mathematical challenges faced by learners and cultivating a fear and burden free learning environment in mathematics classrooms.

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