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MATHEMATICAL EXCELLENCE: HOW ARITHMETIC ABILITIES DRIVE ACHIEVEMENT IN SECONDARY SCHOOLS?

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ABSTRACT

This study explores the crucial role of arithmetic abilities in driving mathematical excellence among secondary school students. Mathematics, the oldest and most foundational of all sciences, significantly impacts various aspects of human life. At its core, arithmetic serves as the basis for understanding more complex mathematical concepts. This research investigates the extent to which students' arithmetical and numerical abilities influence their overall achievement in mathematics. Utilizing a sample of 200 ninth-grade students from 10 English and Hindi medium schools in Delhi NCR, the study employs a self-made achievement test to measure both mathematics and arithmetic proficiency. The findings aim to fill a gap in the literature regarding the relationship between arithmetic skills and mathematical success at the secondary level. The study's outcomes are expected to provide insights for educators and policymakers, emphasizing the importance of arithmetic education as a vehicle for enhancing students' cognitive abilities, problem-solving skills, and logical reasoning, in line with the National Policy of Education (2020).

Key Words: *Mathematical Excellence, Arithmetic and Numerical Abilities, Achievement in Mathematics, Secondary School Students, Cognitive abilities, problem solving skills, logical reasoning, NEP 2020.*

INTRODUCTION

Mathematics is significant in our daily lives because we frequently apply what we have learned in various activities. For instance, tiling floors involves calculating the area size. Understanding percentages is useful for interpreting nutrition labels. Road signs and recipe books often use fractions to indicate distances or ingredient quantities. Managing monthly bills requires mathematical skills, and even hanging pictures straight on a wall involves some knowledge of geometry.

Mathematics, the oldest of all sciences, has evolved over the ages and has a significant impact on the quality of human life. Arithmetic, the foundational branch of mathematics, is rooted in numerical concepts that underpin every mathematical idea. Arithmetical and numerical abilities are known to influence students' achievements in mathematics. Numerous studies have investigated how these abilities affect students' mathematical performance. National Policy of Education (2020) also highlights the importance of mathematics in general education, advocating that mathematics should be seen as a tool

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to train children to think, reason, analyze, and articulate logically. Mathematics excellence represents a profound understanding and proficiency in mathematical concepts, theories, and problem-solving techniques. It encompasses not only the ability to perform calculations accurately but also the capacity to apply mathematical reasoning to real-world situations. Achieving excellence in mathematics requires a combination of strong foundational skills, critical thinking, and creative problem-solving abilities. Students who excel in mathematics are often able to see patterns, make connections between different areas of mathematics, and approach problems from multiple perspectives. This level of proficiency is cultivated through rigorous practice, continuous learning, and a deep appreciation for the beauty and utility of mathematics. Mathematics excellence is not just about achieving high grades but developing a mindset that values precision, logical reasoning, and the relentless pursuit of knowledge.

The ability to do something reflects the quality, acquired skill, or talent. Study habits are crucial in developing talent and problem-solving skills. A study habit is a well-planned and consistent pattern of study that students adopt to understand academic subjects and excel in examinations (Pauk, 1962; Deese, 1959; Akinboye, 1974). Rastogi (1983) investigated how proficiency in basic arithmetic skills influences mathematics achievement, finding that poor arithmetic skills are a significant cause of difficulties in mathematics. The investigator noted that the relationship between achievement in mathematics and arithmetic remains unexplored. Kaur (1985) analyzed abstract mathematical concepts and identified figural angular and numerical facility factors as key in learning and excelling in mathematics for high school students. Sumangala (1995) studied 750 ninth-grade students in Kerala, discovering that numerical ability, numerical reasoning, symbol selection, spatial ability, and abstract reasoning significantly correlate with mathematics achievement. According to Olayinka (1996) and Yahaya (2003), many people view passing exams to secure certificates for higher education or good jobs as the primary goal of education, rather than the acquisition of knowledge and skills through study.

Based on the review of related literature, it is evident that studies examining the effect of Arithmetical Ability and Study Habits on Mathematics excellence at the secondary stage in Delhi have not been conducted so far. Therefore, the investigator believes it is important to conduct research on this topic to fill the existing gap and understand the impact of these factors on students' mathematics achievement at the secondary level in Delhi.

RATIONALE OF THE STUDY

Based on the review of related literature, very few studies find out which showed influence of Arithmetical Ability on the Achievement in Mathematics at Secondary Stage in Delhi. Therefore, the investigator feels it important to conduct the research on influence of Arithmetical Ability on the Achievement in Mathematics at Secondary Stage

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in New Delhi.

OBJECTIVES OF THE STUDY

The following objectives are formulated for this study:

- To study the influence of mathematics excellence on arithmetic ability of IX male and female students.
- To study the influence of mathematics excellence on arithmetical ability of IX English and Hindi Medium students.

HYPOTHESIS OF THE STUDY

The following hypotheses are formulated to empirically validate the above objectives:

- There is no significant difference of mathematics excellence on arithmetic ability of IX standards class male and female students.
- There is no significant difference of mathematics excellence on arithmetical ability of IX class English and Hindi Medium students.

REVIEW OF RELATED LITERATURE

Ketterin Geller (2009) has worked on current approaches to diagnosis in mathematics and highlighted the strengths and limitations of each approach for making instructional decisions. Findings showed that cognitive diagnostic assessments is pointed out as an emerging solution for providing detailed and precise information about student thinking that is needed to provide appropriate educational opportunities for students.

Biswajit Behera(2009) studied problem solving skills in mathematics learning, the major findings were the mean difference between high ability and low ability groups, between boys and girls within each ability group is quite large. Students with high mathematical ability are far superior in mathematical problems.

Saha (2007) conducted a study on Gender, Attitude to Mathematics, Cognitive style and Achievement in Mathematics. It was found that all the three contribute to statistically significant difference in achievement in mathematics.

Hariharan, D.(1992) studied on attitudes of high school students towards homework and achievement in mathematics. Findings showed that girls, urban and private school students have a more positive attitude towards homework as compared to boys, rural and government school students. Also students with this positive attitude have better academic achievements.

RESEARCH DESIGN

The present study is descriptive in nature and survey method will be used on secondary school students of Delhi NCR. The study is delimited to 200 ninth-grade students from 10 English and Hindi medium schools in Delhi NCR, focusing on the subject of Mathematics, and utilizing a self-made achievement test for mathematics and arithmetic ability.

POPULATION AND SAMPLE

The sample will be comprised of 100 boys and 100 girls of standard IX from different

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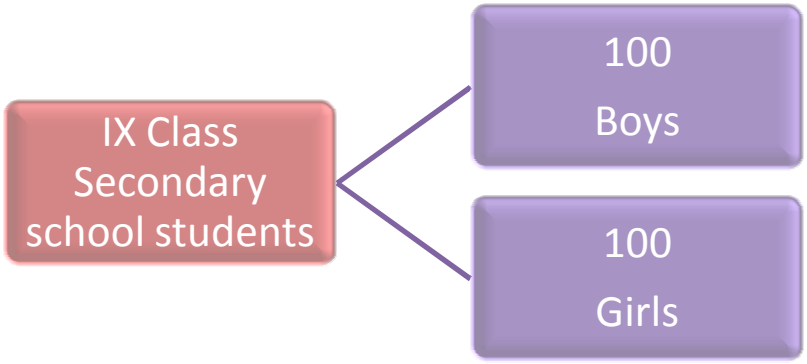
secondary schools of Delhi.



SAMPLING TECHNIQUE

Investigator used stratified random sampling technique to carry out research work.

TOOL USED

The following tools will use in the present study:

1. **Mathematics achievement test:** This questionnaire contained the content based on senior secondary mathematics syllabus and contains multiple choice items and validated with the assistance some senior secondary school teachers.
2. **Arithmetic ability questionnaire:** This questionnaire constructed and validated with the assistance of some senior secondary school teachers.

STATISTICAL TECHNIQUES USED

In order to analyses the data, differential statistical techniques such as mean, standard deviation and t-value were employed and to measure the significant difference among groups.

ANALYSIS OF DATA

The present study was conducted with the aim of examining the mathematical excellence and arithmetic ability of secondary school students with respect to gender & medium of Instruction.

1. Data And Results of Test Of Significance Of Difference Between Mean Scores Of Achievement In Mathematics On The Basis Of Gender And Medium Of Instruction:

TABLE-1

Difference between Mean Scores of Achievement in Mathematics on the basis of Gender

		N	Mean	S.D.	t-value
Gender	**Boys**	**100**	**45.67**	**26.01**	**8.12**
	Girls	**100**	**30.39**	**14.45**	

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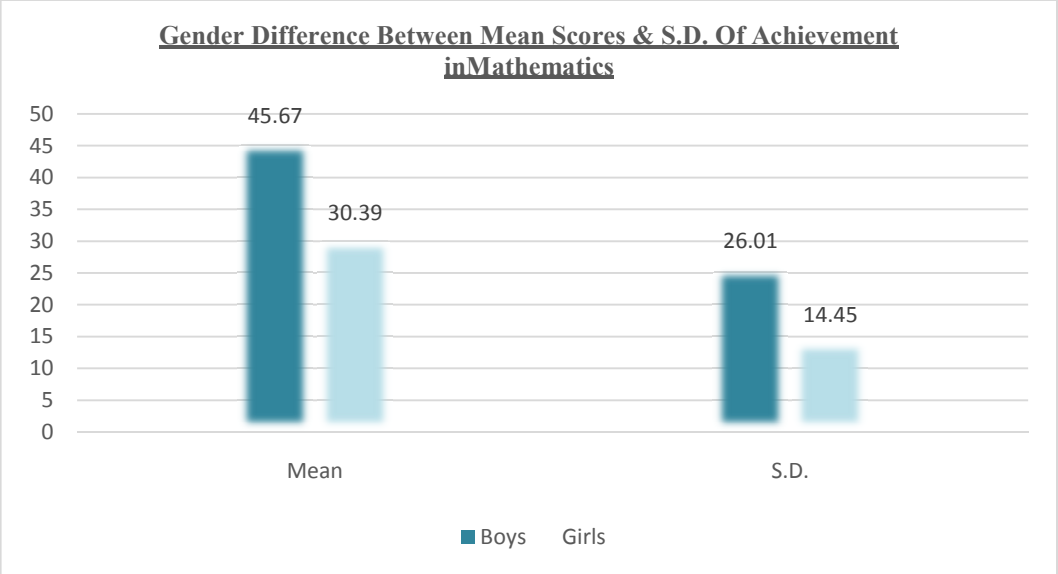

TABLE-2

Difference between Mean Scores of Achievement in Mathematics on the basis of Medium

		N	Mean	S.D.	t-value
Medium	**English**	**100**	**39.48**	**23.01**	**1.45**
	Hindi	**100**	**36.58**	**21.65**	

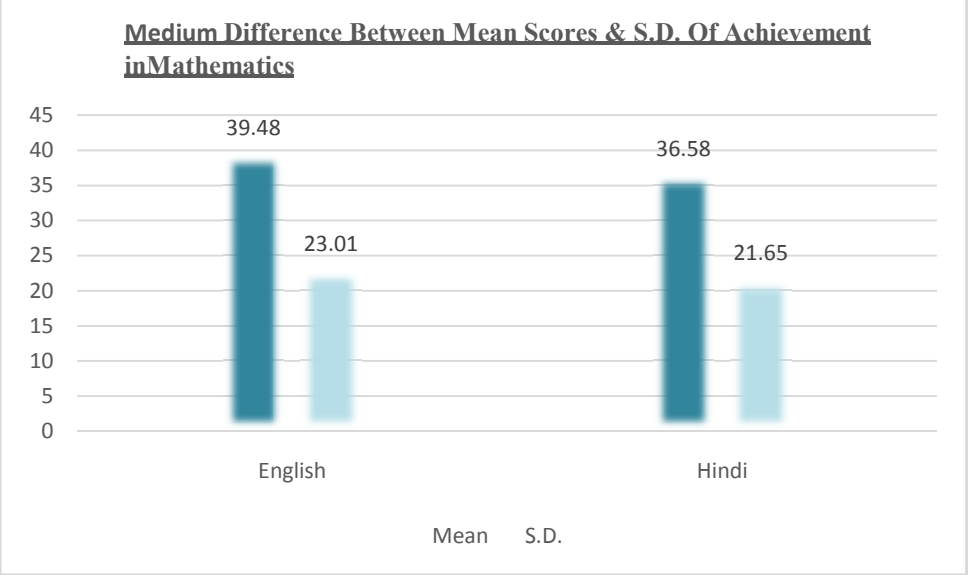

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TABLE-3

Difference between mean scores of arithmetical ability on the basis of gender

		N	Mean	S.D.	t-value
Gender	**Boys**	**100**	**16.80**	**8.10**	**5.09**
	Girls	**100**	**13.25**	**6.43**	

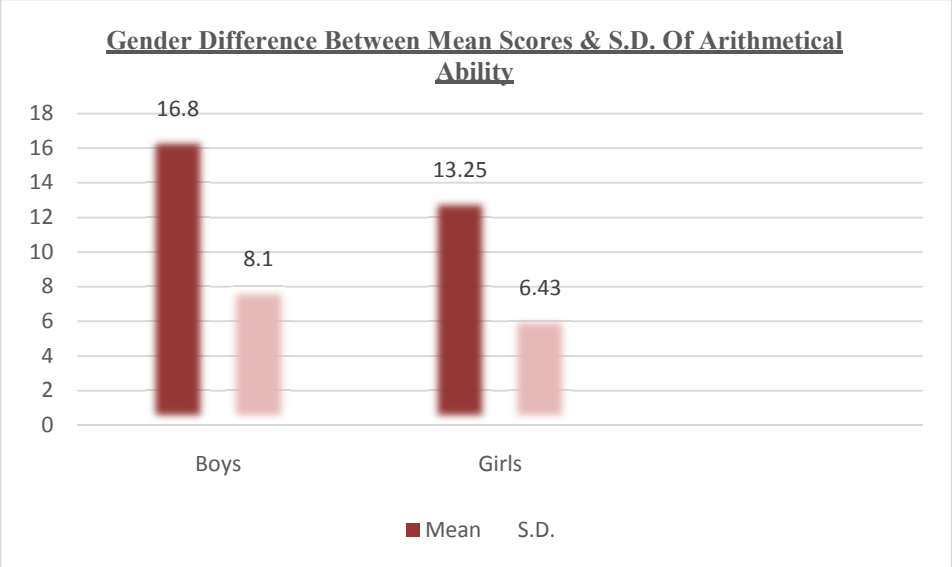

TABLE-4

Difference between mean scores of arithmetical ability on the basis of Medium

		N	Mean	S.D.	t-value
Medium	**English**	**100**	**16.06**	**8.22**	**2.92**
	Hindi	**100**	**13.96**	**7.08**	

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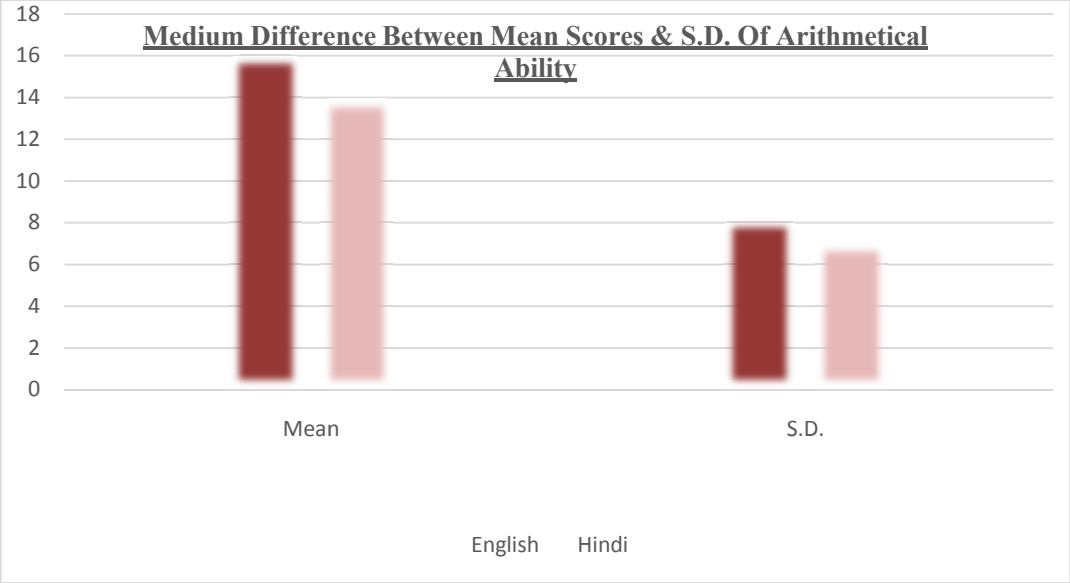

TABLE-5

Significance differences between the means of Achievement in mathematics scores with different Sub categories of arithmetic ability

S.NO.	Sub Category	N	Mean	SD	t-value
1.	High	60	56.35	24.17	2.01
2.	Average	100	35.25	16.42	1.12
3.	Low	40	23.24	13.94	1.18

From table-1 & 2 we observed that regarding achievement there is significant difference between boys and girls (t=8.12, significant at 0.05 level) but not significant between English medium and Hindi medium students (t=1.45, not significant at 0.01 level).It is seen that the mean achievement score for boys (M=43) is higher than that of girls (M=33.06). So it may be concluded that the null hypothesis is rejected for achievement in mathematics for different sub samples of gender and accepted in case of medium. This implies that Boys are high on achievement in mathematics when compared with girl students. But achievement in Mathematics is independent for the sub-categories of medium.

From table-3 we observed that regarding arithmetical ability there is significant difference between boys and girls (t=5.09, significant at 0.05 level) and between English medium and Hindi medium students (t=2.92, significant at 0.05 level). So it may be concluded that the null hypothesis is rejected for arithmetical ability for different sub samples sex and medium. This implies that Boys are high on algebraic ability when

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compared with girl students and Hindi medium students has high arithmetic ability than English medium students.

From table-4 we observed that regarding achievement in mathematics, there is significant difference between sub-categories of arithmetical ability between high and Average (t=9.88), average and low (t=7.12) and high and low (t=14.06).

SUGGESTIONS FOR FUTURE SCOPE OF STUDY

Longitudinal Studies: Conduct longitudinal studies to track the progress of students' arithmetic abilities over time. This can help identify patterns of development, factors influencing growth, and potential interventions for improving mathematical achievement.

Comparative Studies: Compare the effectiveness of different teaching methods, curricula, and instructional strategies in enhancing arithmetic skills among secondary school students. Investigate the impact of factors such as technology integration, personalized learning approaches, and hands-on activities.

Cultural and Socioeconomic Factors: Explore the influence of cultural and socioeconomic factors on arithmetic achievement. Investigate how cultural norms, family background, socioeconomic status, and home environments affect students' attitudes towards mathematics and their performance in arithmetic.

Neuroscience and Cognitive Science: Utilize insights from neuroscience and cognitive science to understand the underlying cognitive processes involved in arithmetic learning. Investigate how factors such as working memory, attention, executive functions, and numerical processing skills contribute to mathematical achievement.

Intervention Programs: Design and implement intervention programs aimed at improving arithmetic abilities among secondary school students. Evaluate the effectiveness of interventions such as tutoring, remedial programs, peer mentoring, and parent involvement initiatives.

Cross-Disciplinary Research: Foster collaboration between mathematics education researchers and experts from other disciplines such as psychology, computer science, and educational technology. Explore interdisciplinary approaches to enhance arithmetic learning through methods like gamification, computational thinking, and adaptive learning systems.

Teacher Professional Development: Investigate the impact of teacher professional development programs on students' arithmetic achievement. Examine the effectiveness of training initiatives focused on pedagogical strategies, content knowledge, formative assessment practices, and classroom management techniques.

Meta-Analytic Reviews: Conduct meta-analytic reviews to synthesize findings from existing research studies on arithmetic achievement among secondary school students. Identify trends, gaps in the literature, and areas requiring further investigation.

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By pursuing research in these areas, educators, policymakers, and researchers can contribute to the development of evidence-based practices that support the improvement of arithmetic abilities and mathematical achievement among secondary school students.

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