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Mathematical Skills Acquisition and Academic Success in Mathematics: A Correlational Study for Grade IX students

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Abstract

Mathematical skills are crucial for students' educational success, critical thinking, and problem-solving abilities. Aligned with the competency-focused education highlighted in the National Education Policy (NEP) 2020, this study aimed to explore the connection between mathematical skills and academic performance in Grade IX students. The research utilised a correlational method based on descriptive survey techniques. The participants were Grade IX learners enrolled in schools affiliated with the Gujarat Secondary and Higher Secondary Education Board (GSHSEB) in Vadodara city for the academic year 2024–2025. Using a basic random sampling method, 261 students were chosen from four different schools. Data was collected utilising a specially designed Student Information Sheet and an Achievement Test focused on Mathematical Skills, which included 25 items evaluating Spatial Awareness, Arithmetic Skills, Algebraic Manipulation, Statistical Reasoning, and Problem-Solving Abilities. The math scores of eighth-grade students served as indicators of academic achievement. The collected data were analysed utilising descriptive statistics and inferential statistical techniques, including Karl Pearson's Correlation Coefficient and Yule's Association Coefficient. The results showed a statistically significant positive relationship between mathematical abilities and academic success among Grade IX students. Pearson's correlation coefficient ($r = 0.402$) demonstrated a moderate positive correlation between students' scores in mathematical skills and their past academic performance in mathematics. Students who excel in mathematics tend to show improved mathematical skills. The research underscores the

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complex and incremental nature of mathematical learning, aligning with the NEP 2020 vision for competency-focused, experiential, and practical math education. The results emphasise the need to improve core mathematical skills to enhance students' educational success, critical thinking, and lifelong learning capabilities.

Keywords: Mathematical Skills, Academic Achievement, Competency-Based Learning, NEP 2020, Mathematics Education, Correlational Study.

Introduction

1. Education and the Role of Mathematics

Mathematics is recognized as one of the most precise and fundamental disciplines created by humans. Mathematics is a fundamental discipline that underpins scientific inquiry, technological advancement, and logical reasoning, influencing nearly every aspect of knowledge and human activity. In everyday life, concepts like ratio, percentage, measurement, area, volume, interest, data analysis, and probability are used in decision-making, financial management, problem-solving, and understanding real-life situations. Mathematics goes beyond being an academic subject; it's an essential skill for navigating today's world.

Mathematics is crucial for students' intellectual growth, enhancing logical reasoning, critical thinking, observation skills, abstract reasoning, problem-solving abilities, and analytical data evaluation. It encourages systematic analysis, separating relevant from irrelevant information, and drawing conclusions based on logical and evidence-supported reasoning. Engaging in mathematics serves as a mental workout that enhances cognitive abilities and fosters intellectual discipline.

The National Focus Group on Teaching of Mathematics emphasised that the primary goal of mathematics education is to develop mathematical reasoning in students, rather than just memorizing procedures and formulas. The Position Paper advocates for a shift from content-centric teaching to meaningful mathematical learning environments that encourage exploration, reasoning, and conceptual understanding. The National Council of Teachers of Mathematics suggested that individuals who understand and can effectively use mathematics will have greater opportunities, choices, and capabilities in an increasingly technological and knowledge-based world. Thus, mathematics education plays a crucial role in the school

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curriculum as it enhances academic abilities and prepares students for active participation in contemporary society.

2. Difficulties in Mathematics and Emerging Concerns

While mathematics is essential, global research indicates that many students struggle to master math and develop basic mathematical skills. Studies like TIMSS and PIRLS show that students lacking critical math abilities in early schooling are more prone to ongoing academic difficulties and educational obstacles. Difficulties in learning mathematics often relate to a weak understanding of numerical concepts, insufficient numerical reasoning, limited problem-solving abilities, shortcomings in memory and visuospatial processing, along with challenges in symbol decoding and logical reasoning (Gilmore, McCarthy, & Spelke, 2010; Lyons & Beilock, 2011; Nieder & Dehaene, 2009).

Studies also demonstrate that mathematical understanding is organized hierarchically, suggesting that a weak understanding of fundamental concepts adversely affects the understanding of advanced concepts. For instance, students with a weak understanding of fractions and basic arithmetic often struggle to progress in mathematics, which may lead to poor performance, reduced self-esteem, and anxiety related to math (Jordan et al., 2017; Tian & Siegler, 2017; Miller & Mercer, 1997). These obstacles impact not just math performance but also general academic achievement and self-assurance in learning.

The educational landscape in India also shows concerns regarding the mathematical skills of school students. Reports like the Annual Status of Education Report and the National Achievement Survey indicate that a large portion of students lack basic arithmetic and mathematical problem-solving skills, even after years of schooling. ASER results from different states revealed a decline in math abilities among primary school students, particularly after the COVID-19 pandemic. The NAS 2021 report showed that a significant number of students performed only at the basic or below-basic level in math. These findings expose persistent gaps in math skills, underscoring the urgent need for effective interventions, competency-focused instruction, and systematic assessment of students' mathematical proficiency.

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3. NEP 2020 and Competency-Based Mathematics Learning

The National Education Policy (NEP) 2020 recognizes mathematical skills as a core element of quality education and continuous learning. The policy highlights a shift from memorization to competency-focused learning that fosters conceptual comprehension, logical reasoning, critical analysis, analytical skills, and practical use of mathematical knowledge. NEP 2020 promotes experiential learning, activity-driven teaching, and competency-focused assessment methods to enhance foundational numeracy and advanced mathematical abilities. The policy also emphasises that mathematics education must empower students to meaningfully utilise mathematical concepts in real-life contexts, critically analyse information, interpret data proficiently, and systematically address practical problems. In this study, mathematical abilities are defined as skills associated with computation, reasoning, interpretation, analysis, problem-solving, and the use of mathematical concepts, crucial for success in education, decision-making, and societal engagement (Ministry of Education, 2020; NCERT, 2023). These abilities are viewed as crucial for success in education, informed decision-making, and active engagement in a technologically advanced and knowledge-oriented society (Ministry of Education, 2020; NCERT, 2023).

4. Relationship Between Mathematical Skills and Academic Achievement

Mathematical abilities and academic success are deeply intertwined. Mathematical abilities serve as the base of a framework that underpins the whole structure of education and cognitive development. Mathematics serves as the foundation of education and cognitive development, enhancing analytical thinking, logical reasoning, precision, and systematic thought. Mathematics is inherently woven into educational systems as it enhances the mental skills required for comprehending, structuring, analysing, and using information efficiently. Students with strong mathematical abilities excel in data analysis, logical reasoning, pattern identification, critical thinking, and informed decision-making across various academic fields. Paired with information processing abilities, mathematics functions as a navigational tool, empowering students to approach complex problems with confidence and clarity. In today's technology-oriented society, proficiency in mathematics is crucial due to the growing reliance on data, digital resources, and computations in academic and work environments. Students skilled in mathematics and information handling exhibit increased self-assurance, independent

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learning, adaptable thinking, and enhanced academic results. Consequently, mathematical abilities impact not just math performance but also overall academic performance, practical skills, job preparedness, and long-term learning outcomes.

5. Need and Significance of the Present Study

In the current educational environment, mathematical skills are considered essential for academic achievement, mental development, and active participation in a knowledge-based society. Despite recognising the importance of mathematics, numerous national and international reports continue to highlight substantial learning gaps, inadequate skill levels, and persistent difficulties that students encounter in schools related to mathematics. These concerns become more important in secondary school, where understanding mathematics supports higher education, scientific literacy, technological abilities, and job opportunities. At the same time, questions about gender equality in math skills continue to attract educational attention due to varying social expectations, educational chances, classroom experiences, and confidence levels among boys and girls. Even with contemporary educational policies supporting equal learning chances and competency-focused education, differences in math performance and participation remain a crucial area for research. Acquiring insights into the mathematical skills of Grade IX students and examining any gender-related similarities or differences can provide valuable perspectives for teachers, curriculum creators, policymakers, and researchers. This research is significant in the context of NEP 2020, which emphasizes mathematics education centered on competencies, skills in critical thinking, and learning based on practical applications. The findings of the research may help identify the existing standard of students' math skills, improve teaching and learning techniques in mathematics, and promote the development of equitable and efficient educational strategies to enhance math competence and academic achievement in high school students.

Methodology

Research Design

This study utilized a Correlational Research Design using descriptive survey methodology to investigate the connection between mathematical abilities and academic performance in Grade IX students. The correlational method was deemed suitable since the research sought to identify the extent and direction of the relationship between students' math skill scores and their

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academic performance scores without altering any variables. The design enabled the researcher to systematically collect, evaluate, and interpret numerical data regarding students' math abilities and academic performance.

Population

The population of the study comprises all Grade IX students studying in schools affiliated with the Gujarat Secondary and Higher Secondary Education Board (GSHSEB) in Vadodara city during the academic year 2024–2025.

Sample and Sampling Technique

The study's sample was selected with the Simple Random Sampling Technique to guarantee an equitable and impartial representation of students. Four schools affiliated to GSHSEB in Vadodara city were selected randomly for the research. From each selected school, approximately 50 % of the Grade IX students were randomly selected as per class sections.

The final sample consisted of 261 students. The school-wise distribution of the sample is presented below:

Sl.No.	Name of the School	Total Students	Type of School
1	Jai Ambe Vidyalaya	102	Private
2	Kelawani English Medium School	78	Grant-in-aid
3	Vidyut Board Vidyalaya	49	Grant-in-aid
4	University Experimental School	32	Private
	Total	261	

Tools for Data Collection

The following tools were used for collecting data for the present study:

1. Student Information Sheet

A self-developed Student Information Sheet was used to collect demographic and academic details of the students, including:

- Name, age, and school,
- Interest in mathematics,
- Frequency of mathematics practice at home,
- Grade VIII mathematics achievement scores.

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2. Achievement Test on Mathematical Skills

An Achievement Test on Mathematical Skills was developed and administered to assess students' competencies in different dimensions of mathematics. The test consisted of 25 items distributed equally across five areas:

- Spatial Awareness,
- Arithmetic Skills,
- Algebraic Manipulation,
- Statistical Reasoning,
- Problem-Solving Ability.

Different question formats such as multiple-choice questions, true/false, fill-in-the-blanks, match the following, and short descriptive questions, were included. Each question carried one mark, making the total score 25 marks. The duration of the test was one hour. The test aimed to measure students' conceptual understanding, reasoning ability, computational skills, and application of mathematical concepts.

Procedure for Data Collection

Before conducting the study, prior consent was secured from the school principals and administrative authorities of the selected schools. The researcher visited the schools in person and conducted the mathematical skills achievement test for Grade IX students under uniform conditions. Clear guidelines about the testing process were given to the students to guarantee consistency and reliability in their answers. Attempts were made to carry out the data collection process without interrupting normal classroom activities. Grade VIII mathematics achievement scores of students were obtained from official school records with approval from school authorities, to analyse the connection between mathematical abilities and academic performance.

Data Analysis

The collected data were systematically classified, tabulated, and analysed using Microsoft Excel and appropriate statistical techniques. Both descriptive and inferential statistical methods were employed.

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Inferential Statistics

To examine the relationship between mathematical skills and academic achievement, the following statistical techniques were applied:

- Karl Pearson's Coefficient of Correlation (r) was used to determine the degree and direction of correlation between mathematical skills scores and academic achievement scores in Grade VIII mathematics.
- Testing for correlation coefficient i.e. to test whether sample correlation coefficient is significant for the population or not.

Statement of the Research Problem

The present study aims to investigate the relationship between mathematical skills and academic achievement among Grade IX students in the context of competency-based mathematics learning emphasized in the National Education Policy (NEP) 2020.

Objective of the Study

To study the relationship between mathematical skills and academic achievement among Grade IX students.

Research Hypothesis

The hypothesis aims to determine whether there is a significant correlation between students' mathematical skills scores and their achievement scores in 8th standard.

Null Hypothesis (H_0): The correlation between the mathematical skills scores and the achievement scores in 8th standard of students is insignificant.

$$Ho: \rho=0$$

Alternative Hypothesis (H_1): The correlation between the mathematical skills scores and achievement scores in 8th standard of students is significant. Mathematically

$$H_1: \rho\neq0$$

Where:

ρ = Population correlation coefficient

r = Sample correlation coefficient

Here researcher has used two-tailed test to check for any significant correlation between the mathematical skills scores and achievement scores in 8th standard of students.

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Statistical Test Used

To test the significance of the correlation, the t-test for correlation coefficient was applied using the formula:

$$t_{cal} = \frac{r * \sqrt{n-2}}{\sqrt{1-r^2}}$$

where:

- t_{cal} = Calculated t-value
- r = Sample correlation coefficient
- n = Sample size
- df = n−2 = Degrees of freedom

Table 1: Rejection Criteria for Testing the Significance of Correlation Coefficient

Null Hypothesis	Alternative Hypothesis	Test statistic	Rejection criterion Reject H_0 if
H_0 : ρ = 0 **Where, ρ is population correlation coefficient**	(1) H_1 : ρ > 0 (2) H_1 : ρ < 0 (3) H_1 : ρ ≠ 0	$t_{cal} = \frac{r * \sqrt{n-2}}{\sqrt{1-r^2}}$ Where r: simple correlation coefficient d.f. = n-2	(1) $t_{cal} > t_{n-2,\alpha}$ (2) $t_{cal} < -t_{n-2,\alpha}$ (3) $\lvert t_{cal} \rvert > t_{n-2,\alpha/2}$

A two-tailed test at a 5% level of significance (α=0.05) was conducted.

- Sample correlation coefficient: r = 0.402994
- Sample size: n = 261
- Degrees of freedom: df = n−2 = 261−2 = 259

Step 2: Compute the Test Statistic

$$t_{cal} = \frac{r * \sqrt{n-2}}{\sqrt{1-r^2}}$$

$$t\ cal = \frac{0.402294 \times \sqrt{261-2}}{\sqrt{(1-(0.402994)^2)}}$$

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$$t\ cal = \frac{0.402294\ x\ 16.09347}{\sqrt{(1 - 0.16184)}}$$

$$t\ cal = \frac{6.4743}{0.9155}$$

$t_{cal} = 7.0718$

Step 3: Determine the Critical Value

For df = 259 at α/2=0.025 (two-tailed test), the critical t-value is:

$t_{tab} = t_{n-2,\ \alpha/2} = t_{261-2,}\ 0.025 = t_{259,}\ 0.025 = 1.969165556$

Step 4: Comparing t_{cal} with t_{tab}

Since $t_{cal} = 7.086$ is greater than $t_{tab} = 1.969$, so we reject the null hypothesis (H_0) at the 5% level of significance.

Interpretation of Results: As the calculated t-value is greater than the critical t-value, we reject the null hypothesis (H_0). This indicates a statistically significant relationship between the mathematical skills scores of students and their achievement scores in the 8th grade. The Pearson correlation coefficient calculated for the students' mathematical skills scores and their mathematics achievement scores from Grade VIII was r = 0.402. This figure reflects a moderate positive relationship between the two variables. In other words, students who excelled in mathematics during the last academic year usually achieve comparatively higher scores in the present Achievement Test on Mathematical Skills. The positive nature of the correlation indicates that an increase in one variable often leads to an increase in the other. As the correlation value is between 0.40 and 0.59, it indicates a moderate linear relationship. This suggests that previous performance in mathematics moderately influences the present mathematical abilities of Grade IX students.

Conclusion

The results emphasize that mathematical abilities are built upon one another and structured hierarchically, with basic comprehension and past learning experiences playing a crucial role in future mathematical achievement. The research highlights the significance of enhancing conceptual comprehension, reasoning skills, problem-solving capabilities, and practical learning from the initial phases of education. The findings of this study closely correspond with the goals of the National Education Policy (NEP) 2020, promoting competency-focused mathematics education instead of memorization. NEP 2020 highlights the importance of

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experiential learning, critical thinking, analytical reasoning, and the practical use of mathematical concepts to enhance higher-order cognitive skills in students. The study reveals a mild positive correlation suggesting that students' academic success increases when they exhibit strong math skills, including computation, interpretation, logical reasoning, and problem-solving. Therefore, the results emphasize the importance of adopting competency-oriented teaching-learning methods and evaluation techniques as outlined in NEP 2020. In today's educational and technological landscape, mathematical competencies are vital not only for success in mathematics as a discipline but also for overall academic achievement, scientific mindset, informed choices, and continuous learning. Consequently, schools and teachers ought to prioritize establishing significant mathematical learning settings that encourage conceptual understanding, active engagement, and practical application of mathematics to improve students' overall academic development and preparedness for the future.

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