Gender Differences in Mathematics Performance: A Comparative Analysis of Successive Terminal Examination Scores

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Abstract

The main purpose of this study was to investigate the differences in mathematics achievement with respect to gender among secondary school students by analyzing examination scores from two consecutive academic terms examination. This study used quantitative analysis techniques to investigate the considerable changes in mathematics achievement between boys and girls and also to explore whether these differences differ from successive terminal examinations or not. This study helps to determine these patterns change between successive terminal examinations or not. This study found the minimal gender differences in the achievement of mathematics. Both groups show the slight decreases in scores from the first terminal examination to second terminal examination but this changes in achievement was not significant statistically in either terms. These results contribute to the ongoing discourse on equality in gender in the achievement of mathematics in specified contents and challenge conventional assumptions about the gender based achievement gaps in mathematics.

Keywords: Mathematics, STEM education, mathematics achievement, professional success

Introduction

Mathematics proficiency is extensively known as a serious skill for academic and professional achievement in the existing 21st century, particularly in the field of STEM (Science, Technology, Engineering, and Mathematics) education (Gibbs, 2010). Besides the significant progress in educational equity, gender differences in performance of mathematics remain a topic of considerable research interest and debate (Lindberg et al., 2010). Historically, different studies have found that gender differences in mathematics achievement, often supporting male students, especially in higher level mathematics and problem solving tasks (Hyde et al., 2008). However,

recent research has challenged these findings, with many large-scale studies suggesting that gender gaps in mathematics have pointed significantly or disappeared completely in many educational contexts (Else-Quest et al., 2010). The Global Gender Gap Report (World Economic Forum, 2023) highlights the progress has been made, disparities persevere in STEM education and careers, with women remaining understated in these fields. Understanding the nature and level of gender differences in mathematics achievement is critical in developing effective educational policies and different interventions was carried out to aim at supporting gender equality in STEM education (Reilly et al., 2019). The comparative analysis of examination scores across different time periods offers valuable insights into the consistency and potential causes of any experiential gender differences.

Review of Literature

For many years, research in education has consistently examined the effect of gender in achievement of mathematics. Some of these studies found the controversial results. Historical data suggested male students are more benefited in achievement on mathematics. The longitudinal studies show a small gender gap in many countries, with some regions showing no significant differences or even females are more befitted in certain domain of mathematics (Hyde et al., 2008; Lindberg et al. 2010). A cross-cultural study on gender differences found significant difference between countries, indicating the sociocultural influences in study (Else-Quest et al., 2010). There was a significant factor in the disparities in the achievement of mathematics. The degree and direction of gender differences differ substantially by content area of mathematics, particularly in geometry and other problem solving and reasoning type of contents. Distinct patterns were found in algebra and arithmetic in the studies with standardized test scores, such as those analyzing with PISA and TIMSS data (Reilly et al., 2019). Moreover, gender differences may change in the academic year with the factors such as stereotype threat, classroom climate, and differential response to different instructional approaches (Ganley & Lubienski2016). It emphasized the significance of looking at performance across multiple assessment points. This review of literature shows the performance may vary due to different factors.

Research related to the effect of gender in mathematics achievement has shifted from a simple gap to understanding a complex interplay of psychological, social, and developmental factors. While many studies find negligible overall differences, boys often got an advantage in

complex problem solving and at the highest performance percentiles, while girls frequently excel in elementary-level computation and school grades. Based on data from over 1.2 million people, the overall gender difference in mathematics performance is negligible (d = 0.05). Lindberg et al. (2010) found that girls achieved slightly better in computation in elementary and middle school, whereas a minor benefit of male in complex problem solving emerged in higher level (d = 0.29). Girls systematically underachieve with comparison to boys, as the gap increasing as the age of children. The gap is small at the lowest percentiles of grade distribution but becomes significantly larger among top-performing children (Di Tommaso et al., 2016). This finding showed there was significant gender difference in mathematics achievement such as boys had higher mathematics concepts, but girls demonstrated higher mathematics achievements in this specific samples. The study supports a "reciprocal effects model" where prior achievement predicts the concept of mathematics and vice versa, the effect of achievement on mathematics concept was found to be stronger (Lee & Kung, 2018). Boys achieved significantly better scores in word problem solving and geometry, but no difference was found in basic operations with numbers (Paz-Baruch & Spektor-Levy, 2024). The analysis of cognitive level on the gender in mathematics found that boys' achievement is greater in knowledge and application levels, whereas girl students have better achievement in understanding level and higher ability levels (Ghimire & Paudel, 2025)

Self-regulated learning (SRL) contributed to mathematics performance across all tasks, and its impact on the gender gap in geometry increased at higher SRL levels (Paz-Baruch & Spektor-Levy, 2024). There were differences in the structure of mathematics achievement between genders, the cooperation and reading attitudes influence mathematics scores. The study suggests that lower mathematics achievement in girls is a primary effect for lower participation in STEM majors at the university level (Bertoletti et al., 2023). Developmental trajectories for mathematics and reading are domain-specific and influenced by unique cognitive and environmental factors (Little et al., 2021). While skills develop rapidly, the phases of development occur on different timelines for boys and girls, often influenced by socio-educational backgrounds (Little et al., 2021). Teachers' attitudes and practices are positively associated with student achievement scores. Teachers' role is associated in the achievement of students. Female teachers reported more positive experiences in teaching and their practices were valued more positively by students (Alnahdi & Schwab, 2023).The relationship between gender

in mathematics performance is significantly mediated by mathematics anxiety (Primi et al., 2018). Men often outperform women on visuo-spatial working memory tests, while no such difference is found in verbal working memory (Primi et al., 2018). The literature consistently shows that the gender gap in mathematics achievement is not a static or worldwide phenomenon. Instead, several recurring themes emerge.

Theoretical Framework

A complimentary framework that addresses both cognitive and social aspects works as the theoretical foundation in the understanding of gender variations in mathematics performance. According to Bandura (1986), social cognitive theory highlights how self-efficacy beliefs and observational learning form mathematical achievement. It also suggests that gender differences may arise from different levels of assurance in one type of mathematical abilities as well as different exposure to mathematical role models. Steele and Aronson's (1995) stereotype-threat offers a framework for understanding the causes of hampered by awareness of critical stereotypes about one's group. This theory is especially relevant the females may perform worse in mathematics while having similar ability levels.

The parents' and teachers' roles in gender and mathematics have a significant impact on students' motivation and their achievement (Wang & Degol, 2017). Eccles' expectancy value theory (Eccles et al., 1983) provides insights into socialization processes that influence the value of individuals and that take place on mathematics and their expectations for success. A framework for understanding the levels of influence observed the performance differences across successive terminal examinations, which is also explained by Bronfenbrenner's (1979) bio-ecological model. This model contextualizes gender differences in different environmental systems, ranging from immediate classroom interactions to broader cultural attitudes about gender roles. In this context, this study explores the achievement of students' mathematical proficiency affected by their gender.

Statement of the Problem

Gender differences in mathematics performance remain inconsistent according to the context of education sectors , age groups, and assessment methods (Lindberg et al., 2010). Furthermore, most studies analyze it as single points in time, with limited care to the effect of gender differences that evolve over the course of an academic year (Voyer & Voyer, 2014).

Additionally, there is no sufficient research examining whether gender differences in mathematics exist across different assessment periods within the same academic year and the same student cohort. This gaps in the literature limits our understanding of the stability of gender differences in mathematics performance affected by educational interventions and different factors of developmental over time. In this context, this study was focused to address the gaps in examining effect of gender differences in mathematics performance by taking two consecutive terminal examinations, providing insights into both the presence and consistency of potential gender disparities in the achievement of mathematics.

Objectives of the Study

The primary objectives of this study are:

1. To compare mathematics achievement between boys and girls in the first and the second terminal examinations;
2. To identify the changes in mathematics performance from first to second term examination within each gender group.

Research Questions

This study was conducted to find the answers to the following research questions.

1. Is there any significant difference in the achievement of mathematics between boys and girls in the first term examination and the second term examination?
2. Do students' mathematics scores change significantly from the first term to the second term examination?
3. Are structures of gender difference in mathematics achievement consistent across both examination periods?

Methods and Procedures

This section of the article deals with the method and procedures for the collection and analysis of data based under different statistical measurements.

Research Design

This study used a quantitative data for comparative research design to analyze the effect of gender in mathematics performance across two consecutive term examinations. The design allowed for both between-group comparisons (boys versus girls) and within-group comparisons (first term versus second term) of mathematics examination scores.

Participants

As the focus of this study was to compare the achievement of students studying grade IX, of a community school of Kathmandu district. Due to different constraints, 57 students from only one school were selected in the study by using the census method. The study included a total of 57 students, comprising 28 boys and 29 girls. All students were taken from the same academic cohort, providing consistency in the sample across both examination periods.

Collection of Data

For the collection of data, the teacher-made achievement test tool was used. The test items were validated by the municipality levels and used in all the schools of located in a municipality (i.e Chandragiri municipality) of Kathmandu district. The terminal examination was conducted to the students as a regular examination schedule. Data were collected from institutional records of mathematics examination scores for both first and second-term examinations during the same academic year. The mathematics examinations assessed similar content knowledge and skills, allowing for meaningful comparisons across the two assessment periods. Table 1 presents the demographic structure of the participants used in this study.

Table 1. *Descriptive Statistics of the sample Students*

Sample Categories	Frequency	Percent
Bramin /Chhetri	15	26.3
Janajati	27	47.4
Dalit	7	12.3
Madhesi	8	14.0
Total	57	100.0

Table 1 shows that that more students were involved from Janajati (an Indigenous group) in the specified sample school whereas the number of Madhesi students was found very less in that class.

Data Analysis

The researcher collected the scores of mathematics students from the specified sample school. These scores were analyzed by using descriptive and inferential statistics, with means and standard deviations. The results were calculated and concluded the mathematics performance of boys and girls in both examination periods. There were 3 months' gaps betwee the first and second terminal examinations. The t-tests in two independent samples were calculated to

compare the performance of boys and girls within each examination period. Further, Levene's test was used to assess the equal variances between groups prior to using t-tests. The 95% confidence intervals (i.e. level of significance α= 0.05) for mean differences were calculated to estimate the precision of the observed differences.

Results and Discussion

This section of the article deals the result of the study after analyzing the collected data. The descriptive as well as inferential statistics were used to analyze the data. The descriptive statistics for mathematics achievement by gender across both examination periods are presented in Table 2.

Table 2. *Comparison of Scores in First and Second Term Examinations*

Scores in mathematics	Gender	N	$\bar{X}$	SD	Std. Error Mean
Score in First Term	Boys	28	24.07	20.749	3.921
	Girls	29	23.07	18.957	3.520
Scores in Second Term	Boys	28	22.39	19.773	3.737
	Girls	29	22.24	17.048	3.166

In the above descriptive statistics table, the mean achievement of boys in first term is 24.07 whereas the mean achievement of the scores of the girls is 23.07. This shows that there was a homogeneity between boys and girl in first term scores. Therefore, the two groups were comparable groups in terms of their preliminary performance in mathematics. There was very small mean difference (1 mark) in both of boys and girls. From this we cannot assure that there was no difference. To determine whether the difference in the achievement of boys and girls was significant or not in two consecutive terminal examinations, ANOVA test was applied as given in Table 3. The results along with two independent samples t-tests by comparing boys' and girls' mathematics performance in both examination periods are given in Table 3.

Table 3. *Use of t-test for Independent Sample for gender difference in Mathematics achievement*

Scores in mathematics		Levene's Test for Equality of Variances				
		F	Sig.	t	df	Sig. (2-tailed)
Score in First Term	Equal variances assumed	.229	.634	.191	55	.850
	Equal variances not assumed			.190	54.145	.850
Scores in Second Term	Equal variances assumed	.876	.353	.031	55	.975
	Equal variances not assumed			.031	53.226	.975

Note: *Date analyzed by using SPSS 27 at 0.05 level of significance*

Gender Differences in First Term Examination

In the first term examination, boys achieved a slightly higher mean score ($\overline{X}$ = 24.07, SD = 20.749) compared to girls ($\overline{X}$ = 23.07, SD = 18.957), representing a small difference of 1.00 points. Levene's test showed that the assumption of equal variances was found (F = 0.229, p = 0.634). The independent samples t-test showed that this difference was not significant as t = 0.191, p = 0.850 > 0.05. This indicates considerable uncertainty in the estimated difference between boys' and girls' mathematics performance. The findings of the data in the population suggest that, the true variance in the achievement in mathematics between boys and girls being no significant difference between the genders.

Analysis of Scores in Second Term Examination

As similar to the first term examination, boys achieved a marginally higher mean score ($\overline{X}$ = 22.39, SD = 19.773) than girls ($\overline{X}$ = 22.24, SD = 17.048) in the second term examination, with smaller difference of 0.15 points. In this results of data, Levene's test determined the

assumption of equal variances (F = 0.876, p = 0.353). The use of t-test between two independent sample found that this difference was not statistically significant t = 0.031, p = 0.975, in the analysis with 95% confidence interval for the second term comparison is similarly wide and centered almost perfectly around zero, further highlighting the lack of meaningful gender differences in mathematics performance.

Comparison between First and Second Term examinations

The difference in first and second term examination, both gender groups showed a decrease achievement in mathematics. The performance from the first to the second term examination, mean scores of boys decreased by 1.68 points (from 24.07 to 22.39), while mean scores of girls decreased by 0.83 points (from 23.07 to 22.24). The slightly larger decrease for boys contributed to small gender gap in first term i.e 1.00 points to 0.15 points in the second terminal examination. This decreases scores from first to second term shows the expansion of course from first terms to second term contributed in their performance. The course in first term was lesser than the course in second term. This shows that if constant study habit is applicable, students' performance is decreasing with the course contents is increasing.

Discussion of findings

The statistical analysis provides strong proof against significant gender differences in mathematics performance in this sample. From these findings different observations emerge. The high p-values (0.850 for first term and 0.975 for second term) are beyond the traditional thresholds. It suggests that there was strong proof to answer the research questions on gender difference in mathematics achievement. The statistical significance differences (1.00 points in first term and 0.15 points in second term) changed slightly in practical aspect, representing around 1% or less possible range of score. The extensive confidence intervals reveal the considerable variation within each gender group and the moderate sample size. However, they consistently include zero that reinforcing the conclusion of no meaningful gender difference. Levene's test results (p = 0.634 for first term and p = 0.353 for second term) confirm that boys and girls exhibited similar variability in mathematics performance. It suggest the comparable varieties within each gender group.

These findings align with the existing research that suggest small or minimum gender differences in the performance of mathematics within contemporary educational settings (Hyde et al., 2008; Lindberg et al., 2010). The significant gender differences in both successive terminal

examination challenges conventional concept in mathematics that the male students are more superior than female in mathematics. As Hyde, (2005), the hypothesis in the similarities in males and females are exists on most psychological variables, including mathematics ability. The small decrease in achievement in both gender groups from first to second terminal examination was no statistically significant suggest further investigation. The reasons that include increasing weight of curriculum produce difficulty, increasing levels of fatigue over the academic year, or variations in assessment content or difficulty affect the achievement (Voyer & Voyer, 2014). The similar decreasing pattern for both boys and girls recommend that there was not the effect of gender. The reliable pattern of minimal gender differences across both examination periods adds strength in findings and suggests that gender is not a significant factor of mathematics performance. This stability through time is particularly valuable, as it indicates that the observed similarities in mathematics performance by gender are not only objects of a particular assessment or time point (Reilly et al., 2019). The relatively large standard deviations found in both male and female groups and across both examination time that highlight the considerable variability in the performance of mathematics. Poor mathematical metacognitive abilities affect the motivation of students to learn, which could decrease the result in mathematics (Paudel, 2024). This considerable change within each gender group exceeds the small change in achievement by gender emphasizing the importance of considering individual differences rather than gender when addressing mathematics achievement (Halpern et al., 2007).

Conclusion and Implications

There exist the gender differences in mathematics achievement across two consecutive term examinations among the students' of grade IX in a community secondary school of Kathmandu, Nepal. For this, a rigorous statistical analysis including independent sample t-tests was used in the 0.05 level of significance. The findings reveal that boys and girls can perform equal in mathematics achievement within similar educational settings. Both gender groups have similar patterns of mathematical performance. The small non-significant decreases in two consecutive terminal examination contribute to the growing body of evidence in challenging traditional assumptions about gender-based achievement gaps in mathematics. The statistical analysis gives strong proof against meaningful gender differences in mathematics performance in school level mathematics. The findings recommend that gender is not a significant determinant factor of mathematics achievement, and that educational approaches should focus on individual

differences rather than gender-based interventions. The consistency in findings across two examination periods supports their validity and recommends that gender similarities in mathematics performance are stable over time. This temporal consistency is particularly valuable, as it indicates the observed patterns are not only responsible of a specific assessment. Finally, this study gives the idea by focusing the importance of addressing individual variations in mathematics achievement rather than focusing on gender as a primary factor. Further, it contributes to ongoing efforts to promote gender equality in studying mathematics and other field of STEM education.

The findings of this study have important implications for understanding effect of gender differences in mathematics achievement. This result is strongly supported the assumption in gender similarities and challenge the views that attribute inherent mathematical advantages to either gender (Hyde, 2005). The consistency of these findings across two examination periods can be expanded into further theoretical position. Many studies reporting significant gender differences in mathematics performances may find statistically significant but practically small differences, or may be subject to publication bias favoring positive findings (Lindberg et al., 2010). The results also align with socio-cultural theories which emphasize the role of environmental factors, rather than biological factors, in designing the performance of mathematics. As suggested by Else-Quest et al. (2010), the performance patterns is similar between boys and girls recommends the both genders are equally capable of succeeding in mathematics with similar educational opportunities and environment.

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