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Gender and Context Differences in the Mathematics Computational Skills of Primary School Students in North-Eastern Pakistan

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Abstract

The study compared the computational skills of primary school students of both sexes enrolled in public and private settings in north-eastern Pakistan. A descriptive quantitative study design was used to collect data. 50 male and 50 female students were randomly selected from 16 private and public sector schools in Muzaffarabad. Initially, a 2-week systematic observation of fifth-grade mathematics classrooms was done. Later, an achievement test of all arithmetic operations based on national curriculum grade-specific math teaching objectives was conducted to assess the gender-wise computational skills of students. The results indicated that gender and school context attributed significantly to the students' test scores. Gender is also found to be a significant predictor in the performance of mathematics computational skills. Male students of grade V from public schools scored significantly less among three other selected groups. Female students from the private sector of grade V scored the highest on average compared to all other groups. Private sector school students scored significantly better compared to public school students. Future research on students' sense of self-efficacy, socioeconomic status, and teaching-learning practices at the elementary level can expand arithmetic education research in Pakistan.

Keywords: *Elementary Education, Gender Gap, School Context, Computational Skills.*

Introduction

Compared to the significance of numerical magnitude representation, research in mathematics education in Pakistan shows relatively small understanding of how children comprehend arithmetic operations (Education, 2021; Mughal, Asad, & Adams, 2020). Arithmetic operations understanding refers to knowledge about the four arithmetic processes and a sense of the application of these skills (Robinson, Dubé, & Kotsopoulos, 2023). Along with performing

arithmetic computations, it also refers to the implicit regularities behind these operations (Monteleone, Miller, & Warren, 2023). It, thus, refers to individuals knowledge of the use of multiplication procedure to determine the total amount required to buy a dozen bananas which cost Rs.50 each, and If they know that the sum of 12 + 5 equals 5 +12 (Wong, 2017).

Recent reform efforts to improve mathematics curricula and pedagogy have expanded understanding of arithmetic operations and skills (Kaup, Pedersen, & Tvedebrink, 2023; McCallum, 2023). The National Research Council Report *Adding It Up* (2001) defines mathematical proficiency as a combination of five strands: one is procedural fluency, second is conceptual understanding, third is strategic competence, fourth is adaptive reasoning, and last is productive disposition. Arithmetic fluency corresponds to the procedural fluency strand; it refers to the ability to perform operations on numbers efficiently. The proposed construct of the arithmetic sense captures the other three strands: conceptual understanding (i.e., knowledge of concepts, operations, and their relations), strategic competence (i.e., the generation of multiple strategies), and adaptive reasoning (i.e., novel mathematical reasoning).

Research shows that the relative skill level for arithmetic operations is established in the early years of school and remains relatively similar for the rest of the school years (Amadon et al., 2022). This is similar to development of reading ability of learners (Chang, 2023). A study by Landerl and Wimmer (2008) finds that the stability in individual variances for reading proficiency was found to be high from grade one to grade eight. Similarly, Watts et al. (2014) found high stability in mathematical achievement in different school grades even if the differences increased.

The school context plays an essential role in student learning and academic achievement in mathematics (Awan and Saeed, 2014. These results are consistent with studies conducted in many regions of the world, and students enrolled in public and private schools achieve different levels of achievement in the mathematical learning standards. Studies show that students in private schools scored higher than students in public schools.; as a result, students from both school systems were reported to have different levels of achievement. (Carbonaro and Covay, 2010; Coulson, 2009). Awan and Saeed (2014) argued that the results of private schools' students in standardized tests show the contribution of these school systems to the eradication of illiteracy and to the improvement of student learning.

Factors related to the public and private schools' achievement gaps are – differences in positive peer help, peer groups' influence, and parental influence. Studies indicate that public school students' social groups are less helpful in their educational tasks than their peers in private schools. The research also suggests for more support to public school students from their teachers in their educational pursuits to improve their achievement (Gottfried et al., 2007). The admission selection process may influence the achievement gap between public and private school students. However, no substantial evidence explains the relationship between the achievement gap and students' selectivity (Yamauchi, 2005). It seems that private schools offer open admission policies to meet their revenue targets to run their school system; this policy, coupled with the popularity of private education among better socioeconomic strata of Pakistani society, may contribute to private schools' perceived better achievement.

Students' attitudes towards solving mathematical problems and applying their computational skills were strong evidence of their mathematical skills (Riegle-Crumb et al., 2011). Students' self-efficacy in solving a mathematical problem was a strong identifier of mathematics

achievement, regardless of their prior academic achievement level. Gottfried et al. (2007) suggest that students' self-efficacy beliefs about their computational skills enhance their mathematics achievement; self-efficacy beliefs could be a positive factor in reducing the achievement gap of students' computational skills in different ethnic groups and genders. Some studies identify the respondents' perceptions of gender as an attribute in learning computation skills. Tiedemann (2000) surveyed 52 primary school math teachers. Teachers were asked to choose six students, three girls, and three boys, from each class from grades 1 to 5 and to place them in three categories: high achievers, mid-performing, and low achievers. The study found that teachers categorized their students' learning ability and proficiency in computational skills based on their students' gender.

Research identifies that male students' performance was associated with less effort in learning skills; however, girls' low achievement in mathematics was associated with their low ability to learn computational skills. Fennema et al. (1990) in the US investigated teachers' perceptions regarding students learning computational skills in grade 1, which researchers found attributed to the learners' respective genders. The studies discussed above thus identify that learning outcomes differ among private and public school students, specifically in basic computational skills. Teachers' perceptions of students' gender were also found to be significant in identifying students' learning outcomes in arithmetic operations.

Objectives of the Study

This study aimed to achieve these objectives:

1. Determine the comparative achievement of both genders in computational skills at the primary level.
2. Identify the effect of school context on students' respective achievements in computational skills.

Research question

1. How does gender affect students' achievement in computational skills in arithmetic?

2. How does school context affect students' respective achievements in the computational skills in arithmetic?

Significance of the Study

The study is significant for multiple stakeholders who are interested in teaching and learning basic computational skills in arithmetic at the primary level. Governments and policy makers are globally anxious to improve the math skills of their population to better prepare them for the information world of today. This study highlights the ability of public and private school students to solve basic arithmetic operations in mathematics. Moreover, this study is also helpful in identifying neglected areas in the learning of arithmetic operations in Pakistan. The research identifies possible contributions to future research exploring other factors in teaching computational skills to early-grade students in Pakistan.

Delimitation of the study

This study was limited to 14 selected schools: 7 public and 7 private sector schools in the Muzaffarabad district, Azad Kashmir. The selected sample size was 120, which is proposed to increase in the future to obtain better results.

Methodology

The study used a comparative descriptive design using a quantitative methodology, which compared the computational skills in arithmetic operations of four groups of grade V students in District Muzaffarabad. This quantitative study used an achievement test to collect data from selected respondents driven by the observation of selected math classrooms—the achievement test based on the national curriculum (2006) grade-specific objectives.

Instrument and Participants

In Muzaffarabad District, 120 students aged 10-12 were selected from seven private schools and seven public schools. The Chit Container method is used to randomly select students from selected grades V schools. Sample students were divided into four groups. Group A consists of 30 boys from public school; Group B consists of 30 girls from public school; Group C has 30 boys from private sector schools, and Group D has 30 girls from private sector schools. All of these groups completed the developed test for basic arithmetic operations.

Classroom Observation

Initially, 5^{th}-grade classrooms were systematically observed for two weeks by researchers, where the teachers in the selected schools conducted lessons from the textbooks on computational skills. Various systematic record-keeping was done of classroom activities of the math lessons in actual classroom settings. Initially, researchers visited four schools, two from each context, and observed fifth-grade mathematics classes for two weeks. Four lessons taught on each of the operations of addition, subtraction, multiplication, and division were observed by researchers delivered by mathematics teachers in each class. A checklist was maintained to keep a record of classroom activities.

The following observations were recorded as field notes.

1. Level of interest. The researcher observed that students in public and private schools showed more interest in addition and subtraction than multiplication and division in mathematics classrooms. Private school students were observed to be more engaged in learning activities that focused on the learning of arithmetic operations.

2. Teaching-Learning Challenges. The researchers observed that students struggled with multiplication and division, and teachers, too, faced challenges in teaching these two operations of computational skills. However, students in both contexts and gender showed interest in arithmetic operations involving addition and subtraction. Moreover, the teachers' time management regarding the difficulty level of corresponding operations was not appropriately managed. Students made more mistakes in multiplication and division, mainly when it involved a multiple-digits function.

Achievement Test:

On the basis of initial findings from field observations, researchers developed an achievement test to assess students' achievement in computational skills in arithmetic operations. A 100-point achievement test targeting computational skills was developed according to the grade-specific subject objectives of the Pakistan 5th grade national curriculum (2006). This achievement test evaluated participant students' basic arithmetic operations' learning in addition, subtraction, multiplication, and division. The test contained a total of 20 questions, five questions for each section of the arithmetic operations. S1 (addition); S2 (subtraction); S3 (multiplication), and, S4 (Division). Thus, the study has a comparative descriptive design, as explained above.

Data Analysis

Researchers analysed the achievement test scores collected through the test of Grade 5th students through ANOVA and t-test. These specific statistical tests were used to compare two to four groups of students with respect to gender and the context of the selected learners. SSPS was used for the analysis of data which is collected from the selected students.

Results

The results of the study showed the following results of achievement tests for all participants across all sections:

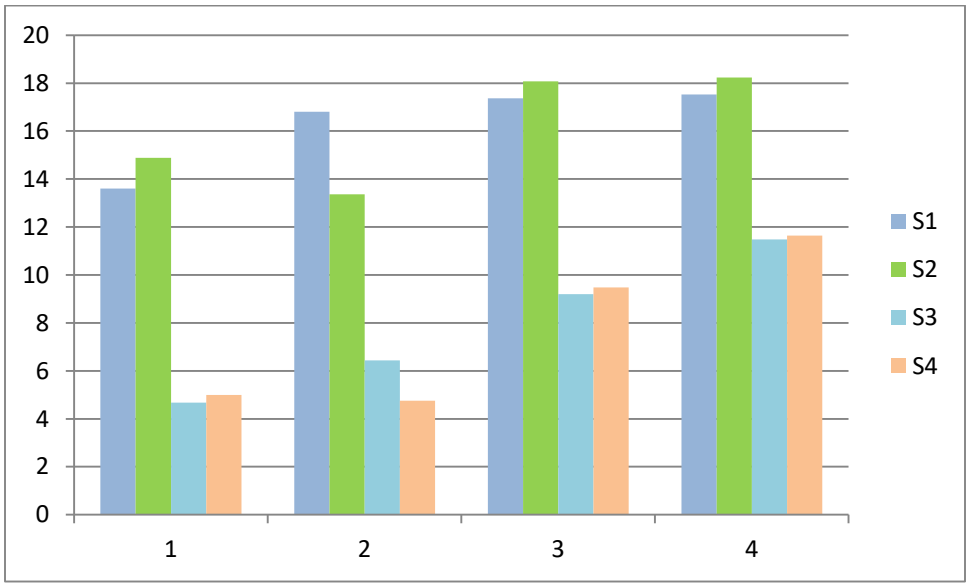
In the achievement test, the general comparison of all groups of participants

Report

VAR00006		S1	S2	S3	S4	Total
1.00	Mean	13.6000	14.8800	4.6800	5.0000	38.3600
	N	25	25	25	25	25
	Std. Deviation	5.70088	5.55518	6.15576	5.61991	14.86854
2.00	Mean	16.8000	13.3600	6.4400	4.7600	40.9600
	N	25	25	25	25	25
	Std. Deviation	6.21155	6.69502	7.24615	7.73671	23.15974
3.00	Mean	17.3600	18.0800	9.2000	9.4800	54.1200
	N	25	25	25	25	25
	Std. Deviation	4.89796	7.22219	7.69199	8.19105	21.05414
4.00	Mean	17.5200	18.2400	11.4800	11.6400	59.0800
	N	25	25	25	25	25
	Std. Deviation	5.19711	7.44021	7.37744	9.33577	22.06037
Total	Mean	16.3200	16.1400	7.9500	7.7200	48.1300

N	100	100	100	100	100
Std. Deviation	5.67091	6.98775	7.50135	8.26466	22.03379

*1= boys in public schools, 2= girls from public schools, 3= boys from private schools, 4= boys from private schools



1. The mean scores of boys in public schools are as follows.

S2=14.88 > S1=13.6 > S4=5 > S3=4.68

This result shows that boys from public sector schools scored higher in S2 with a mean score of 14.88 compared to S1, S3, and S4, while they performed poor in S3 with a mean score of 4.68 compared to their score in S1, S2, and S4.

2. The mean scores of girls in public schools are as follows.

Mean score of S1=16.80 > mean score of S1=13.36 > mean score of S3=6.44 > mean score of S4=4.76

This indicates that girls in public schools scored higher in S1 with a mean score of 16.80 compared to S2, S3 and S4. They performed poor in S4, with a mean score of 4.76 compared to their score in S1, S2, and S3.

3. Mean scores for private school boys are as follows:

Mean score of S2=18.08 > mean score of S1=17.36 > mean score of S4=9.48 > mean score of S3 = 9.20,

This indicates that private school boys scored higher in S2 with a mean score of 18.08 compared to S1, S3 and S4. They performed poor in S3, with a mean score of 9.20 compared to their scores in S1, S2, and S4.

4. The mean scores of the private school girls show the following results:

Mean score of S2=18.24 > mean score of S1=17.52 > mean score of S4=11.64 > mean score of S3 = 11.48,

These results indicates that private school girls scored higher in S2 with a mean score of 18.24 compared to S1, S3 and S4. They scored less in S3, with a mean score of 11.48 compared to S1, S2, and S4. Students' ability to solve addition and subtraction questions was almost similar, and their ability to solve questions of multiplication and division was almost similar, as the mean difference is minimal in both cases.

Discussion

The current study was a comparative study of gender differences and arithmetic skills of public and private school students in the Muzaffarabad district. A difference in public and private sector schools was observed based on observational data of mathematics classrooms in selected schools. The gender was also attributed to the ability to solve the assigned tasks in computational skills. Researchers thus developed an achievement test based on the curriculum's grade-specific objectives and textbooks related to arithmetic operations for 5^{th}-grade students of both genders in selected public and private schools.

The study identified school context and gender as significant predictors of students' scores on the achievement test. The results indicated that boys in public schools performed better in subtraction with a mean score of 14.88 compared to other athematic operations involving addition, multiplication, and division. The researchers observed similar findings during their school visits, when students were found to be more involved in solving subtraction and addition questions than in operations involving multiplication and division.

Private sector students performed significantly better compared to public sector students. In comparison, girls from public schools performed better in a test involving addition than the other three arithmetic operations. Female students from the private sector scored the highest, and male students from the private sector achieved the second highest, whereas female students from the public sector scored the second least, and male students from the public sector scored the least.

The results of these data from the achievement test are consistent with the observation data and the earlier research findings. Researchers observed that public school students are less involved in mathematics learning activities than their grade peers in private schools during school visits. The Carbonaro & Covay (2010) and Coulson (2009) studies also endorsed similar findings. While connecting these consistent findings with Gottfried et al. (2007), who suggested that students' self-efficacy beliefs enhanced their performance – public sector school students' perceptions about themselves might play a role in their low performance.

The difference in students' performance in both contexts may also relate to their respective socioeconomic status. Many studies identify the better socioeconomic status of students attending private schools. Therefore, their different socioeconomic contexts define their access to different academic resources. Private sector school students are more likely to have additional learning time by paying through private tutoring for mathematics if they face problems learning and understanding concepts within traditional classroom setups. In comparison, only a few students in the public sector are likely to have access and capacity to pay for a similar facility.

Research data relating to the study's second research objective found gender to be a significant predictor in 5th-grade students' performance in the achievement test. Female students in both sectors performed significantly better than male students from their respective sectors. Mean S2=18.24>mean score of S1=17.52>mean score of S4=11.64>mean score of S3=11.48, which indicates that girls from private schools scored higher in S2 with a mean score of 18.24 compared to S1, S3, and S4. Tiedemann (2000) reported that female performance in mathematics was attributed to their learning ability, and male students' performance was attributed to their level of interest in learning. Thus, female students worked harder and were more interested in learning computational skills and thus performed better than male students.

Gender is, however, intriguing to connect with the self-efficacy theory of Gottfried et al. (2007). The self-efficacy of the genders might help explain the comparative performance on the achievement test. Further studies can explore the connection of self-efficacy with their respective performances. The study was concluded based on the findings and discussion that students in the private sector performed significantly better than students in the public sector, which shows that they learned better arithmetic skills than students in the public sector. Gender was also a significant attribute in performance in both sectors. Girls performed better on achievement tests than boys in public and private sector schools. Boys in both sectors scored less than girls on the achievement test. Their respective attitudes towards learning can be a reason for their low performance in their respective groups – this, however, would need another study to explore.

While linking the earlier research literature and the findings of this study, future research should be developed to explore the contributing factors that can help explain the achievement gap between students in public and private sector schools and also in connection with their respective genders. These factors may address the socioeconomic status and school environment of students enrolled at the primary level to develop a detailed understanding of the performance gap of mathematics students at the elementary level in Pakistan. Furthermore, research needs to be conducted in other areas of mathematics and computational skill development in primary school students in Pakistan involving school environment and teacher perceptions or attributes towards the achievement gap in mathematics based on their students' gender and grade level. Such studies can help develop a better understanding of teaching and learning practices in this subject area at the elementary level in Pakistan.

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