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Gender Disparity in Students' Performance of Science and Mathematics: Evidence from Nationwide Study in Pakistan

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Abstract

Gender disparity in science and mathematics performance is being researched internationally. In a complex education system, like Pakistan, studying the difference in isolation may not generate holistic understanding. Therefore, this paper investigates changes in trends of performance in Science and Mathematics for both genders across public and private schools. Data were gathered from a nationwide sample of elementary grades students (n=15,391) using SATs/MATS. Independent t-test and two-way-ANOVA were employed to analyse data. Results revealed that girls outperformed boys in Science ($p<0.01$) while no gender differences in performance were observed in Mathematics. Gender and school systems demonstrated significant interaction effect only in mathematics, unveiling that girls perform better in public schools while this difference diminished in the private school system. The results show implications for employing gender-fair policies and practices in science and mathematics education.

Keywords: gender disparity, gender-based performance, science and mathematics achievement, gender difference across school systems, large-scale study.

Introduction

Gender disparity in education in terms of access, attainment, and learning is a multifaceted and complex issue that has remained a topic under exploration by researchers and policymakers around the globe. Much has been discussed about the potential implications of gender disparity on the economic and social development of any given society (Global Education Monitoring, 2020). Being cognizant of facts, several reforms and initiatives have been introduced to overcome gender disparity at almost all levels of education. Encouragingly, gender disparity in terms of enrolment has been reduced over the last two decades. For instance, girls' enrolment in primary and secondary schools increased by 55% in the last 2.5 decades (Global Education Monitoring, 2020). However, evidence related to the gender gap in students' performance, particularly in Science and Mathematics, is inconclusive.

The recent global evidence reveals that some countries have managed to improve girls' performance in Science and Mathematics (TIMSS, 2019; GEM, 2020). On the other hand, in many countries, particularly located in Lower-and-Middle Income Countries (LMICs), the gap still exists favouring boys (Global Education Monitoring, 2022; TIMSS, 2019). One of the main reasons for the gender differences in performance could be due to the stereotypes that influence students' academic matters and ultimately their academic achievements and prospects to pursue their careers in Science and Mathematics disciplines (Brown & Alexandersen, 2020; Lindberg et al., 2010; Wrigley-Asante et al., 2023). In addition, gender stereotypes also contribute to the development of beliefs, choices, and learning attitudes toward Mathematics and Science.

Apart from stereotypes, there are numerous context-specific realities that directly and/or indirectly influence the performance gap by gender. The school system, for example, is one of the decisive factors for school choice and untimely students' performance in many countries, including Pakistan (Aslam, 2009; Kingdon, 2020; Nguyen & Raju, 2014). To be more specific, evidence from large-scale assessment in Pakistan suggests that students enrolled in private schools are performing better than their counterparts in public schools (Bhutta & Rizvi, 2022). Regarding private schooling, Aslam (2009) found that it explains 19% of variation in students' performance in Mathematics; yet girls have significantly lower chances to enroll in a private school (Pasha, 2023). However, when it comes to performance

by gender, studies have found that girls tend to excel in Science while boys tend to perform better in Mathematics in Pakistani schools (Fussy et al., 2023; Shah et al., 2020). This poses critical questions related to gender differences performance, such as, is it gender of students that contribute to the differences? Or is it the innate characteristics of private schools that make a difference in the performance of both, favouring boys due to their high enrolment in private schools? This paper helps in responding to these questions by comparing gender differences in Science and Matahematics performance across the country, followed by comparison of public and private schools, in order to provide a holistic picture.

This study, based on representation of national large-scale data, contributes to the existing body of knowledge in two ways. First, it provides deeper insights and adds to the emerging trends of gender-based differences in students' performance in Science and Mathematics in the context of Pakistan. Second, the paper examines the differences across public and private sector systems, the two main and distinct providers of education. By doing so, this paper contributes to global efforts of gender equality (Sustainable Development Goals, particularly SGDs 4 and 5) in education through unfolding changing trends embedded in the contextual realities of Pakistan. This will be of interest to local and international stakeholders working for gender equality in education.

Research Question

This paper responds to the following research questions:

1. Is there any significant difference in the performance of boys and girls in Science and Mathematics in elementary grades across Pakistan?
2. Are there any separate and interactive effects of student gender and school system, on their performance in science and mathematics?
3. Review of Relevant Literature

Trends of Students' Performance in Science and Mathematics

Gender disparity in Science and Mathematics performance has been extensively studied in almost every part of the world. The most prominent strand of evidence has studied differences in isolation, by examining variations in the scores of girls and boys through standardised achievement tests (TIMSS, 2019). This

strand of evidence has a rich history and broader scope, as it has been generated from the 20th century across the globe. Historically, Science and Mathematics were considered male domains, and boys possessed a strong, stereotyped attitude towards these subjects (Hyde et al., 1990; Starr & Simpkins, 2021), ultimately leading to their better performance (Else-Quest et al., 2010; Makarova et al., 2019; Xie et al., 2023). However, these trends have been subjected to continuous changes with the passage of time, and across various contexts. In other words, the available evidence is inconclusive (Baye & Monseur, 2016; Borgonovi & Han, 2021; Meinck & Brese, 2019; TIMSS, 2019), sometimes revealing no differences in academic achievement (Ajai & Imoko, 2015; Bessudnov & Makarov, 2015; Erturan & Jansen, 2015; Sarouphim & Chartouny, 2016; Tsui, 2007), favouring girls in Science and/or Mathematics (Arora et al., 2012; Global Education Monitoring, 2022; Gonzales et al., 2008; Mullis et al., 2004; Saeed et al., 2005; Shah et al., 2020) or demonstrating boys' better performance in Science and/or Mathematics (Asante, 2010; Edgerton et al., 2012; Kumar & Choudhury, 2022; Lau & Lam, 2017; Reilly et al., 2015; Reilly et al., 2019). Scholars have attempted to consolidate the existing literature through meta-analysis in order to generate a comprehensive understanding of gender differences. For example, Lindberg et al. (2010) conducted a meta-analysis of around 242 studies published over 18 years (1990-2007) and found that both girls and boys have equal performance in Science and Mathematics. On the other hand, a meta-analysis by Ouma and Nam (2015) focusing on developing context, specifically in Africa, reported that boys performed better in Mathematics. However, these results are also inconclusive, confirming the need for context-specific investigation of gender differences in performance.

Schools Systems and Gender Differences

It is argued that studying gender differences without giving due consideration to various associated factors may not provide plausible conclusions. There are a number of associated factors that can directly or indirectly contribute to gender differences in terms of performance in Science and Mathematics. For instance, gender-stereotypical attitudes towards Science and Mathematics subjects – considering Mathematics as male dominant subject (Butt & Dogar, 2014; Nosek et al., 2009) - shapes perceptions and practices of parents, teachers, and students towards these subjects, which ultimately affects students' performance (Kane & Mertz, 2012; Leder, 2019). Nevertheless, the gender stereotype also influences school choice for boys and girls. A survey of Pakistani households found that within

the household, decisions of parents regarding school choice (public or private), and educational expenditure on children, are significantly pro-male oriented (Aslam & Kingdon, 2008). Due to this discrimination within the households, parents prefer to invest more in boys as compared to girls, as evident from studies (Aslam, 2009; Pasha, 2023) that girls have significantly lower chances of being enrolled in private schools. Moreover, similar findings regarding discrimination within households are demonstrated in the Indian context (Kumar & Choudhury, 2022). This leads to the curiosity of whether the difference in performance is due to the gender of students or the school system in which they are enrolled. What comes next is the review of the literature on differences in performance by the school system, necessitating a thorough investigation of the interaction between these two independent variables.

School related factors such as school system (Public or Private) and their effect on students' achievement remained the focus of many research studies (Ahmed et al., 2013; Akhter, 2017; Beese & Liang, 2010; Mohammadpour & Shekarchizadeh, 2015; Thappa, 2015). There is a general assumption that students attending urban and/or private schools perform better in Science and Mathematics. This view is grounded in the concept that schools located in urban areas have more advantages such as infrastructure and human resources as compared to rural schools (Organisation for Economic Co-operation and Development, 2019). In addition, more or less similar views of parents are found towards private and public schools, regardless of school location. Parents prefer private schools instead of public schools because of quality teachers and productive teaching practices, support in preparation for external examination and satisfactory security measures for their children (Andrabi et al., 2008; Ahmed et al., 2013; Akhter, 2017). On the other hand, public schools are struggling to meet the set standards of quality education (Bhutta & Rizvi, 2022). The quality crises in public schools are attributed to various factors including limited basic facilities and a lack of teachers' accountability (Awan & Zia, 2015; Andrabi et al., 2008; Beese & Liang, 2010). Therefore, parents who can bear private school expenses, are more interested in enrolling their children (preferably boys) in private schools, particularly in Pakistan (Andrabi et al., 2008; Pasha, 2023).

In addition, a common theme running through literature revealed that private schools' students performed better in core school subjects including Science and Mathematics in Pakistan (ASER, 2020; Awan & Zia, 2015; Beese &

Liang, 2010; Thappa, 2015). Similar trends have been observed in other countries as well (Malacova, 2007; Nath, 2012; Ndaji et al., 2016; Singh, 2014; Smith-Wooley et al., 2018; Thappa; 2015; Zuilkowski., 2018). The question that arises here is why private schools perform better than public schools? Arguably, public school teachers are required to have specific academic and professional credentials for recruitment while qualification of teachers hired for private schools are not necessarily comparable (Akhter, 2017; Singh, 2014).

Context of the study

Pakistan is geographically divided in six regions namely Punjab, Sindh, Khyber Pakhtunkhwa, Balochistan, Azad Jammu Kashmir, and Gilgit Baltistan. The system of education comprises elementary (1-8 grades), secondary (9-12 grades), and university (undergraduate, graduate, and postgraduate programmes) levels. The education system of Pakistan mainly comprises two sectors: public schools managed by the government, and private schools managed by non-governmental organisations. Pakistan education statistics (2017-18) demonstrated public schools accommodating 56% of children (Boys = 55%; Girls = 45%) whereas the remaining 44% are enrolled in private schools (Boys = 56%; Girls = 44%). There are also differences in the language of instruction, examination systems, and textbooks, between the public and private schools (AEPAM, 2018). However, despite these differences, Science and Mathematics education has remained an important part of formal schooling in both systems. This could be due to the significance of Mathematics and Science as essential disciplines for addressing practical problems. Mathematics helps in understanding the underlying patterns and relationships among phenomena and their abstraction, while Science enables a comprehensive understanding of the quality and interconnectedness of objects and phenomena in the environment (Beswick & Fraser, 2019; National Research Council, 2012). The importance of these disciplines is becoming increasingly significant in the 21st century, both globally and locally, and their relevance in schools persists to date (Nakakoji & Wilson, 2020). In the Pakistani school systems, students learn Science and Mathematics from their early grades (ECCE) to elementary levels (Grade VIII) as mandatory courses. Thus Science and Mathematics education at the school level is offered to both boys and girls, and provides the same exposure to all students, regardless of the sector.

Methodology

This paper is extracted from nationwide research conducted in elementary schools in Pakistan (Bhutta & Rizvi, 2022). A cross-sectional survey design was used in this study. The data were gathered from 15343 students of grades 5, 6, and 8, recruited from 153 randomly selected schools (government=78; private=75) from 25 districts having representation from all the six regions of Pakistan (i.e., Punjab, Sindh, Khyber Pakhtunkhwa, Balochistan, Gilgit Baltistan, and Azad Jammu & Kashmir).

For assessing students' performance, which is the focus of this paper, valid and reliable Mathematics Achievement Tests (MATs) and Science Achievement Tests (SATs) were used for each target grade (Bhutta & Rizvi, 2022). In order to assess the internal consistency of the tools, Cronbach's Alpha was computed for SATs and MATs and found to be in the satisfactory range (0.60 to 0.78) for both SATs and MATs across grades. The weightage of items in terms of content in both SATs (i.e., Biology, Physics, Chemistry, and Earth Sciences) and MATs (i.e., Number & Operations, Geometry & Measurement, Algebra, and Information Handling) and cognitive levels (i.e., knowledge, application, and reasoning) was aligned with National Curriculum 2006. The test items included Multiple Choice Questions (MCQs) as well as Constructed Response Questions (CRQs). All the MATs and SATs consisted of 30 items, except grade 5, which had 20 items. In addition, information about the demographic characteristics of students (e.g., gender, school system) were gathered through demographic questions. Students were made to sit in examination setup in order to minimise peer influence, and they completed each test in 50 to 60 minutes in the presence of the researcher. The data were collected between October 2018 and January 2020.

The data analysis encompasses multiple steps. First, the CRQs were marked using a pre-developed rubric after establishing inter-rater reliability. The MCQs were marked through SPSS. The mean percentage scores were used for the analysis. After meeting all the key assumptions of parametric tests (normality and equality of variance), an independent t test was employed to compare the differences. Furthermore, the magnitude of differences was also estimated by computing effect size (r). Benchmarks for effect size were determined as small (r =0.1), medium (r=0.3) and large (r=0.5) (Field, 2017). Finally, two-way ANOVA was run to see if the two independent variables (gender and school system) have an interaction effect

on the dependent variable (students' scores in SATs and MATs).

Results

Demographic Characteristics of the Sample

Of the total 15,391 students recruited for the study, the gender-wise distribution revealed almost equal representation with a slight greater participation of boys (n=7968; 52%) than girls (n=7423; 48%). The variance in gender ratio is the manifestation of the enrolment rate of boys which is greater than girls in the country (UNESCO, 2021; NEMIS, 2019). Furthermore, school system-based distribution of the sample shows that relatively a larger number of students from public schools (n=9270; 60%) participated in this study than students from the private schools (n=6121; 40%). This pattern was consistent for gender-based comparison in both, public and private sector schools. For instance, there were more girls in public schools (n= 4777; 31%) than private schools (n= 2627; 17%), and the same trend for boys was observed as well. The less participation of girls from private schools validates the findings of Aslam (2009) and Pasha (2023), who reported that parents gave less chances to their female children to be enrolled in private schools.

RQ 1: Is there any significant difference in students' performance between girls and boys?

The results of an independent t-test, presented in table 1, revealed that girls have significantly outperformed boys' in science ($p<0.001$), while there was no significant difference in mathematics achievement.

Table 1

Table Comparison of Students' Performance in Science and Mathematics by Gender

Subject	Gender	N	Mean (SD)	t	p	Effect size
Mathematics	Boys	7939	26.90 (15.78)	-1.378	0.169	n.s
	Girls	7404	27.21 (14.83)			
Science	Boys	7893	33.21 (16.63)	-7.179	0.001	r=0.06
	Girls	7394	35.10 (15.47)			

These results suggest that girls have shown a better understanding of scientific concepts, while both girls and boys have demonstrated similar performance in Mathematics. Interestingly, girls have an edge over boys in Mathematics; however, the difference is not statistically significant ($p > 0.05$). Notably, regardless of gender, students have performed better in science as compared to Mathematics.

RQ2: Are there any separate and interactive effects of student gender and school system, on their performance in science and mathematics?

The results of two-way ANOVA as given in table 2 help to understand the separate and interaction effect of student gender and school system for mathematics and science achievement.

Table 2

Results of two-way ANOVA for Students' Mathematics and Science Performance by Gender and School System

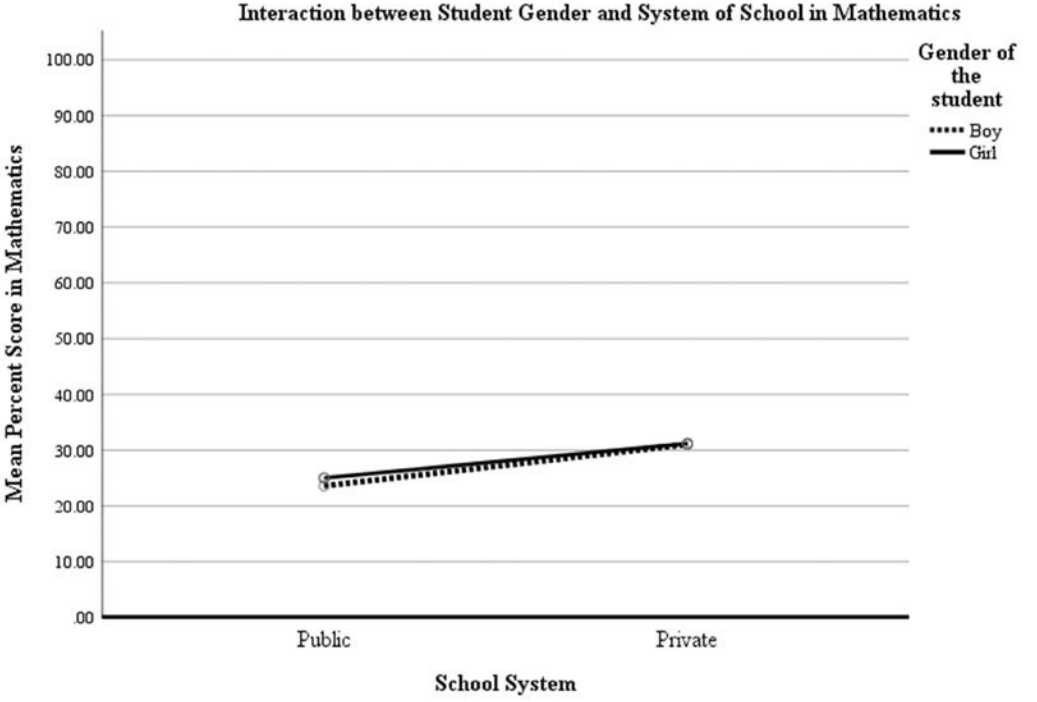
Source	Sum of square	df	Mean square	F	p	Effect size (eta square)
Mathematics						
Gender	2176.442	1	2176.442	9.735	0.002	0.001
School system	168226.948	1	168226.948	752.475	0.001	0.047
Gender*system	1435.451	1	1435.451	6.421	0.011	0.000
error	3429258.735	15339	223.565			
Science						
Gender	25599.355	1	25599.355	109.635	0.001	0.007
School system	381496.794	1	381496.794	1633.847	0.001	0.097
Gender*system	219.992	1	219.992	0.942	0.332	ns
error	3568520.849	15283	233.496			

In mathematics, there was a significant main effect of both gender ($F = 9.735$, $p<0.01$) of students and system of school ($F = 752.475$, $p<0.01$) on students' performance. Further, As depicted in Figure 1, there was a significant

interaction effect between the school system and gender on students' performance in Mathematics. Gender differences within each system of school helped to understand the pattern further. The results indicated that girls from public schools have significantly performed better in mathematics than their counterparts boys ($p< 0.05$). Similarly, girls enrolled in private schools came at par to boys in private schools ($p>0.05$). This interplay indicates that it is not simply the gender of students that brings variations in performance, but the system of school equally contributes. More specifically, when there are equal opportunities in terms of school access, then there would be higher chances for girls to perform either better than or equal to boys in Mathematics. In other words, girls can compete with boys or even perform better (evident from within public school comparison) in Mathematics given that equal and enough opportunities were provided to them.

Figure 1

Interaction between Student Gender and System of Schools in Mathematics

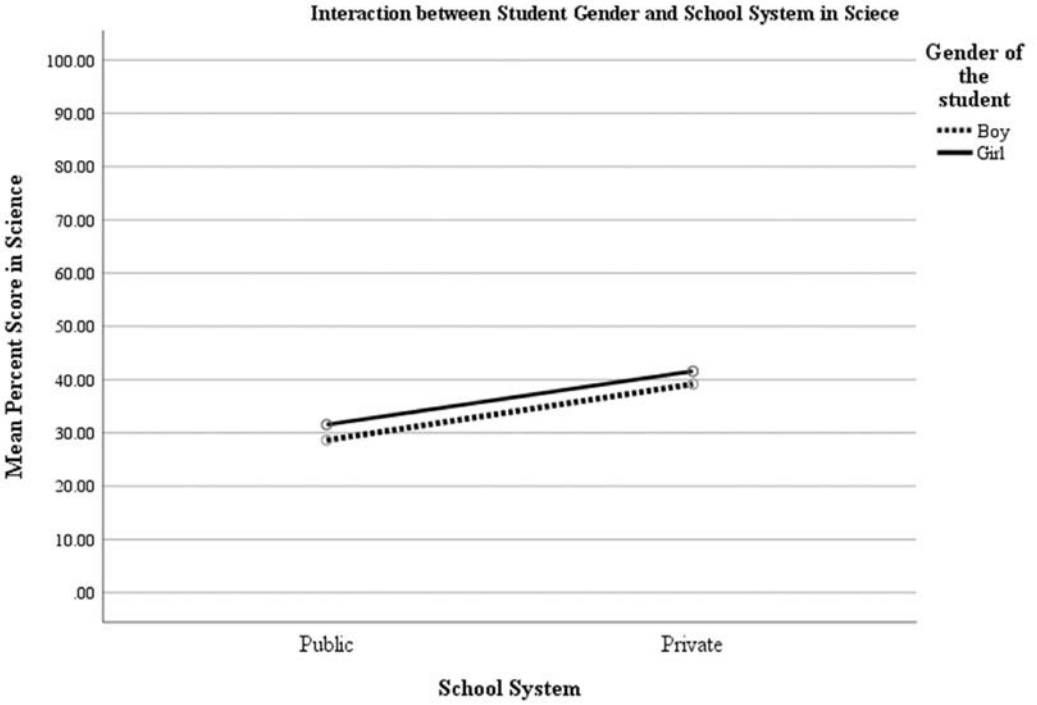


In science, gender ($F = 109.635$, $p<0.01$) and system of schools ($F=1633.847$, $p<0.01$) demonstrated significant main effect on students' performance. Figure 2

shows that there was no interaction effect between system of school and gender on students' performance in Science ($p>0.05$). This indicates that it is the gender of students which accounts for differences in the test score, in favour of girls. In other words, girls would tend to perform significantly better in science the, regardless of the schools that they are enrolled in.

Figure 2

Interaction between Student Gender and System of Schools in Science



Discussion

The gender disparity in terms of performance in the core school subjects like Science and Mathematics has remained a long-standing issue in Pakistan. This study not only provided evidence related to the current status of gender disparity in academic performance in Science and Mathematics, but also dissected the differences by studying how the trends vary in different systems of schools. It is important to note that the findings presented in this paper are from a context in

which girls are facing numerous challenges, such as, social and cultural constraints, economic disadvantage and discrimination in terms of access to education (Ali et al., 2023; Aslam, 2009; Jamal, 2016). Despite these challenges, the study indicates that girls have overcome the longstanding gap in Mathematics performance, which is consistent with the recent evidence of TIMSS (2019). However, there is still work to be done to ensure that girls have a strong foundation for pursuing careers in science related fields. Despite all these challenges, the existing performance of girls can serve as a source of motivation for the government, parents and other stakeholders to invest and prioritise more on girls' education in order to increase their participation in Mathematics and Science related fields.

This study found that girls' performance in Science is significantly better than that of boys. The findings are consistent with a plethora of studies undertaken globally (Arora et al., 2012; Global Education Monitoring, 2022; Gonzales et al., 2008; Mullis et al., 2004) and in Pakistan (Saeed et al., 2005; Shah et al., 2020) indicating better performance of girls. The findings are encouraging for the policy makers and practitioners who are constantly striving for gender equality in students' performance. At the same time, it demands serious attention from the policy makers to sustain better performance and retain girls in science-related disciplines till higher education as well as career selection. However, evidence shows that girls' performance, as well as enrolment and completion, declines as they progress to upper grades (Ali et al., 2023; Bhutta & Rizvi, 2022).

This paper shows interesting trends in Mathematics achievement by highlighting that girls came at par with boys in Mathematics performance. The findings are important for two reasons. First, it has generated new trends in Mathematics performance in favour of girls and shown contrasting results to studies that reported boys as performing better in Mathematics (Anjum & Godil, 2019; Khan et al., 2020; Kumar & Choudhury, 2022; Ullah et al., 2020). Secondly, the findings also confront the 'genetic disposition' claiming Mathematics as a subject for boys (Butt & Dogar, 2014; Nosek et al., 2009). Thus the stereotype attitude towards poor performance of girls in Mathematics no longer holds true, at least in the context of Pakistan.

Furthermore, gender stereotypes can have an impact on girls' confidence in studying Science and Mathematics, potentially affecting their performance

(Steegh et al., 2019). These stereotypes can be influenced by the content and learning experiences students encounter both inside and outside of school (Kang et al., 2019). However, the results of this study indicate that girls tend to perform well in Science and Mathematics, regardless of the school system. This could be attributed to their positive self-perception and favourable learning experiences, which motivate them to excel in these subjects. Conversely, boys may experience anxiety when competing with girls in these subjects, which negatively impacts their performance. Additionally, boys may develop a negative attitude towards learning Mathematics if they perceive themselves as low achievers, thus creating resistance to their own learning (Keller et al., 2022). Whereas girls with similar levels of anxiety may choose to pursue different career paths instead.

The differences in gender performance can be explained by various factors that mediate the influence of gender on student achievement. These factors include teachers' beliefs about gender differences, enrolment in public or private schools, family background, cultural aspects, and accessibility to education (Bessudnov & Makarov, 2015; Jamal, 2016; Organisation for Economic Co-operation and Development, 2019). In this study, a segregated analysis based on the school system was conducted to examine whether it contributes to gender differences in students' performance.

The analysis of performance differences by gender within public and private school systems reveal interesting findings. It suggests that girls can perform equal to or better than boys when provided with equal opportunities in terms of school choice. More specifically, in public schools, girls demonstrated significantly better performance in both Mathematics and Science. Similarly, girls in private schools achieved higher scores in Science, and have an edge over boys in Mathematics. This indicates that the combination of students' gender and the school system plays a crucial role in their performance in Mathematics. Therefore, one cannot solely attribute low performance to gender alone, at least in mathematics, but must consider the influence of the school system as well. It is important to note that girls have fewer opportunities for enrolment in private schools (Aslam, 2009; Pasha, 2023), yet they can compete with boys in Mathematics, and outperform in Science. The evidence suggests that the quality of private schools in Pakistan, as determined by students' learning outcomes and teaching quality, is higher (Bhutta & Rizvi, 2022), and girls' exposure to quality education can make a significant difference.

Conclusion and Recommendations

The evidence presented in this paper contributes to understanding Pakistan's progress towards achieving SDG 4 (quality education) and SDG 5 (gender equality). Regarding SDG 4, the evidence indicates that there is a long way to go in ensuring the provision of quality education at the school level, as reflected by the low mean percentage scores for both boys and girls, indicating a "learning crisis" (Ahmad, 2022). Recent studies support this argument, particularly if Pakistan's performance is seen in TIMSS (2019), placing it at the bottom level internationally and nationally showing that over 80% of students have weak or basic understanding of Science and Mathematics concepts (Bhutta & Rizvi, 2022). This evidence puts pressure on the government to prioritise and improve the quality of education at the school level. Regarding SDG 5, the evidence suggests that Pakistan has made significant progress in raising the performance of girls in Science and Mathematics at the school level, but the question is to what extent girls are retained in science-related fields in professional life. More importantly, this paper's findings can help challenge the long-standing stereotype that girls are not good at Mathematics, especially in developing countries. By ensuring equal opportunities for girls in terms of access to education, there is a greater probability that they can pursue careers in Mathematics-related fields.

Findings suggest that students' performance in elementary schools would benefit by system specific interventions at practice and policy levels. More specifically, development and implementation of gender-fair pedagogical practices and policies would lead to improved students' learning outcomes in science and mathematics. The findings also generate opportunities for future research to explore factors which contribute to gender differences and encourage educators to offer interventions to bridge this gap.

References

AEPAM. (2018). *Pakistan Education Statistics 2016-17*. Pakistan. Accessible at http://library.aepam.edu.pk

Ahmad, S. (2022). *Do schools, as they are, work?* IED Blog https://www.aku.edu/iedpk/blog/pages/Post_Details.aspx?pid=37

Ahmed, M., Mahmood, T., Mhyuddin, M. S., & Ghuman, M. A. (2013). Evaluation of school effectiveness of secondary education system: Comparative view of public

and private institutions of Pakistan. *Journal of Educational and Social Research.* https://doi.org/10.5901/jesr.2013.v4n3p121

Ajai, J. T., & Imoko, B. I. (2015). Gender differences in Mathematics achievement and retention scores: A case of problem-based learning method. *International Journal of Research in Education and Science, 1*(1), 45-50.

Akhter, N. (2017). Factors affecting parents' inclination towards the private school system in Pakistan. *Journal of Elementary Education, 27*(2), 49-69.

Ali, S., Ansari, A. N., Ahmed, M., Ahmed, Z. I., Siddique, N. S., Shaikh, N., Solangi, S., Khatri, M., & Lateef, T., (2023). Policy analysis of girls' primary school completion in rural Sindh: Root causes and policy recommendations using IIEP education policy toolbox: A case study. https://resources.norrag.org/resource/view/775/437

Andrabi, T., Das, J., & Khwaja, A. I. (2008). A dime a day: The possibilities and limits of private schooling in Pakistan. *Comparative Education Review, 52*(3), 329-355.

Anjum, G., & Godil, A. (2019). Fear of achievement among young women in urban Pakistan: A phenomenological analysis of fear of achievement (FOA). *Cogent Social Sciences, 5*(1), 1666620. https://doi.org/10.1080/23311886.2019.1666620

Arora, A., Foy, P., Martin, M. O., & Mullis, I. V. S. (2012). *TIMSS 2011: International results in Mathematics*. Chestnut Hill: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College/ International Association for the Evaluation of Educational Achievement.

Asante, K. (2010). Sex differences in Mathematics performance among senior high students in Ghana. *Gender and Behaviour, 8*(2). https://doi.org/10.4314/gab.v8i2.61947

ASER. (2020). *Annual status of education report (ASER), 2019 Pakistan.* Lahore: ASER Pakistan Secretariat, Idara-e-Taleem-o-Aagahi (ITA).

Aslam, M. (2009). Education gender gaps in Pakistan: Is the labor market to blame?. *Economic Development and Cultural Change, 57*(4), 747-784.

Aslam, M., and G.G. Kingdon. (2008). Gender and household education expenditure in Pakistan. *Applied Economics* 40 : 2573–91.

Awan, A. G., & Zia, A. (2015). Comparative analysis of public and private educational institutions: A case study of District Vehari-Pakistan. *Journal of Education and Practice, 6*(16), 122-130.

Baye, A., & Monseur, C. (2016). Gender differences in variability and extreme scores in an international context. *Large-scale Assessments in Education, 4*, 1-16.

Beese, J., & Liang, X. (2010). Do resources matter? PISA Science achievement comparisons between students in the United States, Canada, and Finland. *Improving Schools, 13*(3), 266-279.

Bessudnov, A., & Makarov, A. (2015). School context and gender differences in mathematical performance among school graduates in Russia. *International Studies in Sociology of Education, 25*(1), 63-81.

Beswick, K., Fraser, S. (2019). Developing mathematics teachers' 21st century competence for teaching in STEM contexts. (2019). *ZDM Mathematics Education, 51,* 955–965. https://doi.org/10.1007/s11858-019-01084-2

Bhutta, S. M., Rizvi, N. F. (2022). Assessing teachers' pedagogical practices and students' learning outcomes in Science and Mathematics across primary and secondary school level: A nationwide study (2018-21). *Aga Khan University, Institute for Educational Development, Karachi, Pakistan.,* 1-4.

Borgonovi, F., & Han, S. W. (2021). Gender disparities in fear of failure among 15-year-old students: The role of gender inequality, the organisation of schooling and economic conditions. *Journal of Adolescence, 86*, 28-39.

Brown, G. R., & Alexandersen, K. (2020). Gender equality and gender gaps in mathematics performance. *Trends in Cognitive Sciences*, *24*(8), 591-593.

Butt, I. H., & Dogar, A. H. (2014). Gender disparity in Mathematics achievement among the rural and urban high school students in Pakistan. *Pakistan Journal of Social Sciences, 34*(1), 93-100.

Edgerton, J. D., Roberts, L. W., & Peter, T. (2012). Disparities in academic achievement: Assessing the role of habitus and practice. *Social Indicators Research, 114*(2), 303-322. https://doi.org/10.1007/s11205-012-0147-0

Else-Quest, N. M., Hyde, J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in Mathematics: a meta-analysis. *Psychological Bulletin, 136*(1), 103.

Erturan, S., & Jansen, B. (2015). An investigation of boys' and girls' emotional experience of Mathematics, their Mathematics performance, and the relation between these variables. *European Journal of Psychology of Education, 30*(4), 421-435.

Field, A. (2017). *Discovering Statistics using SPSS* (5th ed.). London: Sage.

Fussy, D. S., Iddy, H., Amani, J., & Mkimbili, S. T. (2023). Girls' participation in Science education: structural limitations and sustainable alternatives. *International Journal of Science Education,* 1-21.

Global Education Monitoring (GEM) Report (2020). A new generation: 25 years of efforts for gender equality in education. Gender Report.

Global Education Monitoring (GEM) Report, (2022). Gender report, deepening the debate on those still left behind. https://doi.org/10.54676/RCZB6329

Gonzales, P., Williams, T., Jocelyn, L., Roey, S., Kastberg, D., & Brenwald, S. (2008). Highlights from TIMSS 2007: Mathematics and Science achievement of US

fourth-and eighth-grade students in an international context. NCES 2009-001. *National Center for Education Statistics*.

Hyde, J. S., Fennema, E., & Lamon, S. J. (1990). Gender differences in Mathematics performance: a meta-analysis. *Psychological Bulletin, 107*(2), 139.

Jamal, A. (2016). Why he won't send his daughter to school—Barriers to girls' education in northwest Pakistan. *SAGE Open, 6*(3), 215824401666379. https://doi.org/10.1177/2158244016663798

Kane, J. M., & Mertz, J. E. (2012). Debunking myths about gender and Mathematics performance. *Notices of the AMS, 59*(1), 10-21.

Kang, H., Calabrese Barton, A., Tan, E., D Simpkins, S., Rhee, H. Y., & Turner, C. (2019). How do middle school girls of color develop STEM identities? Middle school girls' participation in Science activities and identification with STEM careers. *Science Education, 103*(2), 418-439.

Keller, L., Preckel, F., Eccles, J. S., & Brunner, M. (2022). Top-performing maths students in 82 countries: An integrative data analysis of gender differences in achievement, achievement profiles, and achievement motivation. *Journal of Educational Psychology, 114*(5), 966.

Khan, R. M. G. B., Chachar, G. B., & Abro, I. A. (2020). Mathematics achievement of Grade VIII students based on the International Standardised Test (TIMSS) in an urban context of Sindh, Pakistan. In *2020 3rd International Conference on Computing, Mathematics and Engineering Technologies (iCoMET)* (pp. 1-4). IEEE.

Kingdon, G. G. (2020). The private schooling phenomenon in India: A review. *The Journal of Development Studies, 56*(10), 1795-1817.

Kumar, D. & Choudhury, P. K. (2022): Do parental resources reduce the gender gap in math for primary school-going children? Evidence from India, *Education 3-13,* DOI: 10.1080/03004279.2022.2133546

Lau, K., & Lam, T. Y. (2017). Instructional practices and Science performance of 10 top-performing regions in PISA 2015. *International Journal of Science Education, 39*(15), 2128-2149. doi:https://doi.org/10.1080/09500693.2017.1387947

Leder, G. C. (2019). Gender and Mathematics education: An overview. *Compendium for Early Career Researchers in Mathematics Education*, 289-308.

Lindberg, S. M., Hyde, J. S., Petersen, J. L., & Linn, M. C. (2010). New trends in gender and Mathematics performance: a meta-analysis. *Psychological Bulletin, 136*(6), 1123.

Malacove, E. (2007). Effect of single-sex education on progress in GSCE. *Oxford Review of Education, 33*(2), 233-259. doi:https://doi.org/10.1080/03054980701324610

Meinck, S., & Brese, F. (2019). Trends in gender gaps: Using 20 years of evidence from TIMSS. *Large-Scale Assessments in Education, 7*(1), 1-23.

Mohammadpour, E., & Shekarchizadeh, A. (2015). Mathematics achievement in high- and low- achieving secondary schools. *Educational Psychology, 35*(6), 689-713. doi:https://doi.org/10.1080/01443410.2013.864753

Mullis, I. V., Martin, M. O., Gonzalez, E. J., & Chrostowski, S. J. (2004). *TIMSS 2003* International Mathematics report: Findings from IEA's trends in international Mathematics and Science study at the fourth and eighth grades. *TIMSS & PIRLS International Study Center. Boston College, 140 Commonwealth Avenue, Chestnut Hill, MA 02467.*

Nakakoji, Y., & Wilson, R. (2020). Interdisciplinary learning in mathematics and science: Transfer of learning for 21st century problem solving at university. *Journal of Intelligence, 8*(3), 32.

Nath, S. R. (2012). Factors influencing primary students' learning achievement in Bangladesh. *Research in Education, 88*(1), 50-63. doi:https://doi.org/10.7227/RIE.88.1.5

National Research Council. (2012). *Fueling Innovation and Discovery: The Mathematical Sciences in the 21st Century*. National Academies Press.

Ndaji, F., Little, J., & Coe, R. (2016). A comparison of academic achievement in independent and state schools. *Durham: Centre for Evaluation and Monitoring, Durham University.*

NEMIS. (2019). Pakistan Education Statistics 2017-18. http://library.aepam.edu.pk/Books/Pakistan%20Education%20Statistics%202017-18.pdf

Nguyen, Q., & Raju, D. (2014). Private school participation in Pakistan. *World Bank Policy Research Working Paper*, (6897).

Nosek, B. A., Smyth, F. L., Sriram, N., Lindner, N. M., Devos, T., Ayala, A., ... & Greenwald, A. G. (2009). National differences in gender–Science stereotypes predict national sex differences in Science and math achievement. *Proceedings of the National Academy of Sciences, 106*(26), 10593-10597.

Organisation for Economic Co-operation and Development. (2019). *PISA 2018 assessment and analytical framework. Paris: OECD.* doi:https://doi.org/10.1787/b25efab8-en.

Ouma, C., & Nam, J. (2015). A meta-analysis of gender gap in student achievement in African countries. *International Review of Public Administration, 20*(1), 70-83.

Pasha, H.K. (2023). Gender differences in education: Are girls neglected in Pakistani society?. *Journal of Knowledge Economy*. https://doi.org/10.1007/s13132-023-01222-y

Reilly, D., Neuman, D. L., & Andrews, G. (2015). Sex differences in Mathematics and Science achievement: A meta-analysis of national assessment of educational progress assessments. *Journal of Educational Psychology, 107*(3), 645-662. doi:10.1037/edu0000012

Reilly, D., Neumann, D. L., & Andrews, G. (2019). Gender differences in reading and writing achievement: Evidence from the National Assessment of Educational Progress (NAEP). *American Psychologist, 74*(4), 445.

Saeed, M., Gondal, M. B., & Bushra. (2005). Assessing achievement of primary grader students and factors affecting achievement in Pakistan. *International Journal of Educational Management, 19*(6), 486-499. doi:DOI 10.1108/09513540510617436.

Sarouphim, K. M., & Chartouny, M. (2016). Mathematics education in Lebanon: Gender differences in attitudes and achievemnt. *Educational Studies in Mathematics, 94*(1), 55-68.

Shah, Z. A., Malik, M. A., & Akhtar, J. H. (2020). Exploring the impact of demographic variables gender, parental education and locality on science achievement at 8th and 9th grades. *Bulletin of Education and Research, 42*(1), 185-198.

Singh, A. (2014). Test score gaps between private and government sector students at school entry age in India. *Oxford Review of Education, 40*(1), 30-49. https://doi.org/10.1080/03054985.2013.873529

Smith-Wooley, E., Pingault, J. B., Selzam, S., Rimfeld, K., Krapohl, K., Stumm-von, S., . . . Plomin, R. (2018). Differences in exam performance between pupils attending selective and non-selective schools mirror the genetic differences between them. *Science of Learning, 3*(3), 1-8. doi:doi:10.1038/s41539-018-0019-8.

Starr, C.R., Simpkins, S.D. (2021). High school students' math and science gender stereotypes: relations with their STEM outcomes and socializers' stereotypes. *Social Psychology of Education, 24*, 273–298. https://doi.org/10.1007/s11218-021-09611-4.

Steegh, A. M., Höffler, T. N., Keller, M. M., & Parchmann, I. (2019). Gender differences in Mathematics and Science competitions: A systematic review. *Journal of Research in Science Teaching, 56*(10), 1431-1460.

Thappa, A. (2015). Public and private school performance in Nepal: An analysis using the SLC examination. *Education Economics, 23*(1), 47-62. https://doi.org/10.1080/09645292.2012.738809

TIMSS. (2019). TIMSS 2019 International results in Mathematics and Science. International Association for the Evaluation of Educational Achievement (IEA). https://timss2019.org/reports/wp-content/themes/timssandpirls/download-center/

TIMSS-2019-Internationa

Tsui, M. (2007). Gender and Mathematics achievement in China and the United States. *Gender Issue, 24*(3), 1-11. doi: DOI 10.1007/s12147-007-9044-2.

Ullah, R., Ullah, H., & Allender, T. (2020). Girls Underperforming in Science: Evidence from Khyber Pakhtunkhwa, Pakistan. *Journal of Elementary Education, 29*(2), 1-14.

Ullah, R., Ullah, H., & Bilal, M. (2020). Biological versus Feminists Perspectives on Girls' Underperformance in STEM Subjects in Pakistan. *Liberal Arts and Social Sciences International Journal (LASSIJ), 4*(1), 10-18.

UNESCO. (2020). *Inclusion and education: all means all.* Global Monitoring Report.

UNESCO. (2021, March). *Education and Literacy by Country. UNESCO* http://uis.unesco.org/en/country/pk#slideoutmenu

Wrigley-Asante, C., Ackah, C.G. & Frimpong, L.K. (2023). Gender differences in academic performance of students studying Science Technology Engineering and Mathematics (STEM) subjects at the University of Ghana. *SN Social Sciences, 3*(12). https://doi.org/10.1007/s43545-023-00608-8

Xie, F., Yang, Y. & Xiao, C. (2023). Gender-math stereotypes and mathematical performance: the role of attitude toward mathematics and math self-concept. *European Journal of Psychology of Education, 38*, 695–708. https://doi.org/10.1007/s10212-022-00631-y

Zuilkowski, S. S., Piper, B., Ong'ele, S., & Kiminza, O. (2018). Parents, quality, and school choice: Why parents in Nairobi choose low-cost private schools over public schools in Kenya's free primary education era. *Oxford Review of Education, 44*(2), 258-274. doi: https://doi.org/10.1080/03054985.2017.1391084