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Full Length Research Paper

Girls on the frontline: Gender differences in mathematics achievement in Manicaland province, Zimbabwe

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Mathematics achievement has for some time been predominantly a male domain, with boys known to be superior to girls. This study sought to assess the magnitude of difference (if any) between boys and girls on mathematics achievement as measured by standardized achievement tests. A closer look was also paid at analyzing whether differences in mathematics are affected by location or level of education. A quasi-experimental design was employed to gather data, with a sample of 18 706 participants. Participants were randomly selected resulting in 52% and 48% participants as males and females respectively. The results show a significant difference in the performance of boys and girls on standardized achievement tests with girls performing better than boys in mathematics (t=-9.697 significant at 1% confidence level and t=-3.106 significant at 5% confidence level at Primary and Secondary levels respectively). Analysis by grade levels indicates narrowing performance gaps between girls and boys from grades 4 to form 3. Results are almost similar across different levels of education and locations. Better scores were observed in urban areas than in rural areas. The better performance of girls when compared to boys is attributed to a shift in attitudes, with current views suggesting that girls can perform equally to boys in mathematics.

Key words: Achievement, differences, gender, mathematics.

INTRODUCTION

Traditionally, it has been consistently stated in scientific research and circular arguments that the girl child is not only inferior and underrepresented but also largely outperformed by the boy child in mathematics, (Feingold, 1994; Halpern, 2000). The underlying philosophy behind equal access to education was to create a level learning field and courses that cater to the needs and aspirations of all students by using a variety of teaching and assessment strategies. Gender equality issues have been championed in various forums and there has been an incessant call to put the girl child on the academic frontline, according them rights and opportunities to excel in previously gender differentiated domains like mathematics.

Biological explanations have re-emerged in recent scholarship on the underrepresentation of women in the sciences in general and mathematics in particular. Gender differences in academia have been explored in great detail, with results generally indicating that males perform better than females on external examinations (Lydeamore, 1993; MacCann, 1995; Stobart, Elwood and Quinlan, 1992; Whitehouse and Sullivan, 1992; Willis, 1989) and assessments comprising multiple-choice items (Sharma and Meighan, 1980; Stobart et al., 1992; Whitehouse andSullivan, 1992; Willis, 1989, all as quoted by Cox in Journal of Research in Rural Education, 2000). However, more and more research is showing school-based assessment and course-work components of mathematics assessment beginning to favour females (Kimball, 1989; Lydeamore, 1993; MacCann 1995; Parker in Rennie and Parker, 1991; Stobart et al., 1992; Whitehouse and Sullivan, 1992). The foregoing runs

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contrary to the perceived role that social factors play in creating gender differences in test scores and there is now considerable interest in understanding this development in order to gain insight into the magnitude and factors behind any changes in mathematics achievement between boys and girls in examinations.

Mathematics education has always been a topical issue in Zimbabwe, particularly considering the low pass rates in the subject. As an indispensable tool for the appreciation and application of science and technology, mathematics is critical as a precursor to the much needed technological and national development. The stereotypes that girls and women lack mathematical ability persist, despite mounting evidence of gender similarities in math achievement, (Hedges and Nowell, 1995).

The assumption that someone's sex can be used as a predictor of their abilities and interests maybe deep rooted in patriarchy and the resultant gender bias and discrimination. Research has consistently shown that there are no significant differences in liking of mathematics between boys and girls; in contrast, there is an equally consistent sex difference in mathematics anxiety/confidence, with girls being more anxious than boys when approaching mathematics, (Hyde, Fennema, Ryan, Frost and Hopp, 1990). However, this difference may be attributed to social reasons, females being less willing to express high confidence as learners of mathematics even if they may have the ability. Substantial research on gender differences in mathematics has been based on North American and European samples.

Recently, however, works such as *The War Against Boys* (Sommers, 2000) have drawn attention to areas in which girls surpass boys. Unfortunately, it is not clear why girls have an edge over boys in specific areas and whether they can maintain the advantage across the school years. This present study sought to highlight whether this status quo has been unlocked in the gender liberalized education systems such as prevailing in Zimbabwe. The study examines the magnitude of gender differences in mathematics achievement in Manicaland province of Zimbabwe. Manicaland province has been recording the best results at both primary and secondary levels in the country. The stride for this study was to assess if any significant difference existed between boys and girls in this province in terms of mathematics achievement against a background of contrasting international viewpoints showing either females being poorer or better in the discipline.

Pomerantz, Altermatt, and Saxon, (2002) argue that there is clear evidence that girls outperform boys in terms of their grades in school. This sex difference is evident in stereotypically feminine subject areas, such as reading, spelling and writing (American College Testing Program, 1997). Moreover, despite stereotypical expectations to the contrary, girls also receive equal or higher grades than boys in stereotypically masculine subject areas, such as math and science (American College Testing Program, 1997; Jacobs, 1991; Pomerantz et al., 2002). It would be interesting to find out whether girls outperform boys in both stereotypically feminine and masculine areas particularly in third world contexts where social and economic factors run deeper and militate against the girl child. Stereotypes about female inferiority in mathematics stand in distinct contrast to the findings reported in previous studies as Bhana (2005) alludes.

This discrepancy is particularly problematic because such negative stereotypes can impair math test performance and cause anxiety via stereotype threat (Blascovich, Spencer, Quinn, and Steele, 2001). Reviewing evidence from research with infants and preschoolers, Spelke (2005) concluded that gender similarities are the rule in the development of early number concepts. Girls earn better grades in mathematics courses through the end of high school (Dwyer and Johnson, 1997; Kenney-Benson, Pomerantz, Ryan, and Patrick, 2006). Zirima and Nyanga, (2012), did not find any significant differences in the mathematics achievement of boys and girls on a standardized achievement and on school based tests.

Student achievement in any subject area is greatly affected by the area in which a student lives. Reasons for the variations in achievement are geographic location, resources, availability of technology, and quality of teachers. The National Education Association said that the low performing youth are in public rural schools (Brown and Swanson, 2001). In Zimbabwe, rural and peri-urban areas have lagged behind urban schools in educational achievement, although some improvements have been made between 1992 and 2000, (Ministry of Education Annual report, 2001).

Brown and Swanson, (2001) postulates that there is a large math achievement gap between rural and non rural areas, but some rural areas are above average and others are just average.

It is common assumption that rural schools are detrimental to student achievement, but these schools have proven to be advantageous for several reasons. First of all, the small size of rural schools helps to assuage and combat poverty, (Brown and Swanson, 2001). Since there are fewer students in rural schools, their funding does not have to be comparable to schools with thousands of students. Additionally, rural schools tend to have low student/teacher ratios, which allows for more individualized attention and assistance in areas of student difficulty, (Halseth and Ryser, 2004).

It is against this background that this particular study sought to assess if rural schools use these advantages to outperform urban schools in mathematics achievement and if there are any significant differences between boys and girls with regards to mathematics achievement in Manicaland, Zimbabwe. To enhance reliability and validity, standardized achievement tests were used.

Purpose of the study

The purpose of this study was to assess the magnitude of differences between boys and girls in terms of their mathematics achievement.
The specific objectives were:

1. To determine the magnitude of difference in mathematics performance between boys and girls at primary school level.
2. To assess the magnitude of difference in mathematics performance between boys and girls at secondary school level.
3. To assess the degree of difference in mathematics performance between boys and girls in rural areas, peri-urban and urban areas.

Hypotheses

The following null hypotheses are hereby stated:

Ho1: There are no significant differences between the Mathematics achievement of male and female students at primary school level in Manicaland, Zimbabwe.
Ho2: There are no significant differences between the Mathematics achievement of male and female students at secondary school level in Manicaland, Zimbabwe.
Ho3: There are no significant differences between the Mathematics achievement of male and female students by location in Manicaland, Zimbabwe

RESEARCH METHODOLOGY

The researchers made use of quantitative research specifically employing a quasi-experimental design. The use of a Quasi-experimental design involves selecting groups of participants upon which a variable is tested, (Shuttleworth, 2008). The variable in this case was mathematics achievement. The merits of quasi-experimental design is that it can often be integrated with individual case studies; the figures and results generated often reinforce the findings in a case study, and allow some sort of statistical analysis to take place, (Zirima, 2012). For instance, findings from the quasi-experiment were integrated with findings from in-depth interviews.

Sampling

Stratified random sampling was employed in this research. There are seven districts in Manicaland and four districts were randomly selected. Schools were stratified according to location (that is, rural, peri-urban and urban) with the exception of Mutasa district which is all rural. A total of 115 schools were randomly selected from the districts.

To ensure a representative sample, the ZIMSEC grade seven and ordinary level examinations rankings of 2009 in Manicaland were used in each district. Within the stratified locations every sixth school per district per grade was picked. Boarding and private schools (Missionary and Trust) schools were excluded from the sample. The above tables 1.1 and 1.2 show the number of schools sampled per district for the primary and secondary levels respectively. Variations in number of schools per district are due to different number of schools per district which may correlate to district size. The tables include a sub divisional breakdown with regard to location (urban, peri –urban and rural).

Mathematics Achievement Tests were administered to students from grades four to six at primary school level and forms one to three at secondary level. Grades one to three were exempted from the study because their performances cannot be tracked since they were not yet in formal school during the period of educational achievement concern. Grades seven and Form four students were excluded from this study in order not to distract them in crucial national examinations.

At school level, researchers randomly selected students from all streams in grades four to six and forms one to three. A total of 18706 students participated in the study, with breakdown shown in table 1.3. 49.3% of the primary school participants were male, while the remainder was female. 47.9% of the secondary school participants were male, while the remainder was female. This therefore meant that male students who participated in this study constituted 48% of the sample population whilst females constituted 52%. Three headmasters and teachers were conveniently sampled from two primary schools and one secondary school. An educational psychologist was also engaged as the other resource person in the in-depth interviews.

Research Instruments

The adapted Wide Range Achievement Test Revised –Math subtest was used. The L1 and L2 were used for primary and secondary schools respectively. The test is accepted by the Zimbabwe Ministry of Education, Sport, Arts and Culture. The test can be used for group testing which was convenient for the large sample size.

The test scores were translated to grade and term equivalents using the relevant scale. The tests were administered midway during the year and therefore the analysis was based on expected scores for mid year performance. The actual scores were analyzed and compared to the expected scores to indicate current performance level and achievement gap.

Research procedure

Education Ministry officials (mostly teachers at each school) and Provincial Psychological Services officials administered most of the instruments in person. At the schools, the researchers first sought for permission from the local management. Tests were administered in a class set-up. Every student was allowed a desk and the classroom would have a maximum of thirty students. Two invigilators were assigned per class and the test lasted thirty minutes. Considering the breadth the area to be covered and subsequent distance that was traveled by the researchers, respondents were asked to complete the tests while the researchers wait to collect them.

In-depth interviews

In order to ensure some validity the research In-depth interviews triangulated three groups of resource persons who comprised headmasters, mathematics teachers and an educational psychologist.

Data analysis

Data was analyzed using The Statistical Package for Social

Table 1.1. Showing distribution of primary school that participated in the study.

District	Primary	Urban	Peri-urban	Rural
Mutasa	11	-	-	11
Mutare	19	8	4	7
Chipinge	6	1	-	5
Makoni	29	4	1	24
Total	65	13	5	47

Table 1.2. Showing distribution of secondary schools that participated in the study.

District	Secondary	Urban	Peri-urban	Rural
Mutasa	8	-	-	8
Mutare	17	4	5	8
Chipinge	8	1	-	7
Makoni	17	2	-	15
Total	50	7	5	38

Table 1.3. Showing Distribution of Participants by Sex and District.

	Primary			Secondary		
District	**Male**	**Female**	**Total**	**Male**	**Female**	**Total**
Mutasa	545	530	1075	342	419	761
Mutare	2289	2472	4761	1562	1529	3091
Chipinge	447	414	861	657	784	1441
Makoni	2010	2020	4030	1127	1270	2397
Total	5291	5436	10727	3688	4002	7690

Science (SPSS Version 16). The sample size was large enough to allow for inferential statistics. The t-test for independent samples was used to test for differences.

The analysis relied on raw scores entered and results were translated to Grade/Form equivalence for purposes of interpretation.

RESULTS

The independent samples t-test analysis was used to test the first and second hypotheses that there are no significant gender differences in pupils' performance in both primary and secondary school respectively, Table 2. The differences at primary level are highly significant at 1% confidence level. On average girls are one term ahead. At secondary level, the differences are significant at 5% confidence level with girls performing better than boys (less than a term difference).

Table 3 shows highly significant differences at 1% confidence interval at primary level and significant differences at 5% confidence interval at forms 2 and 3. On average girls performed better than boys. There were no differences at form three levels. Tables 2 and 3 indicate decreasing performance gaps from primary to secondary level.

The study also tested the third hypothesis stating that there are no gender differences in mathematics achievement by school location and findings are as shown below.

Girls are performing better than boys in all locations. However, there is a decline in achievement from urban to rural. Urban students perform better than peri-urban and rural schools have the least achievement levels. All differences reported were highly significant at 1% level of confidence. See annex 1.0 for details.

Figure 1 indicates that girls perform better than boys in all locations, with urban students performing the best and rural performing the least. The differences are highly significant at 1% confidence interval. See Annex 1.1 for details. The results of this study revealed that girls achieved significantly better in mathematics achievement tests when compared to boys. This difference was witnessed at both primary and secondary school levels and in peri-urban, rural and urban population (Figure 2).

In-depth interviews revealed that there was a gradual change in attitudes and stereotypes. Previously, there were stereotypes that females could not achieve mathematically at the same level with males. It is largely these stereotypes which have perpetuated the underperformance of girls in mathematics when compared to their male counterparts. However, the shift in attitudes probably explains the improved performance of girls in mathematics. The current attitude is that girls can equally perform like boys in mathematics. Learner's attitudes can have an impact on how females and males solve mathematical problems.

DISCUSSION

Results show significant differences between male and females in favor of females. This result contradicts a number of studies conducted in rural African communities. For instance Awofala (2011) concluded that there exists significant gender difference in rural students' mathematics achievement in favor of males in Nigeria. The results also indicate decreasing performance gaps from primary to secondary levels, with no significant differences at form 3 level. These results are consistent with findings by Dwyer and Johnson, 1997; Kenny-Benson et al., 2006; Blithe et al., 1994 and at form 3 level with Linn (2010) who meta-analyzed international data sets of students aged 14 to 16 years and found no gender differences in mathematics achievement, but contradict with findings by Hyde et al (2008) who found no gender differences in grades 2 to 11.

The study indicates that girls outperformed boys in all locations with urban students performing better than peri-urban. Rural students performed the worst. The location of schools appears to affect male and female performance, with studies in Canada suggesting that

Table 2. Differences in performance between male and females by school type.

School type	Mathematics performance				Performance difference (terms)	t-value
	Male		female			
	Mean	Std dev	Mean	Std dev		
Primary	25.65 (n=5314)	5.272	26.62 n=5454	5.129	1	-9.697***
Secondary	25.14 (n=3666)	6.413	25.59 (n=3982)	6.367	<1	-3.106**

***significant at 1% **significant at 5%

Table 3. Gender differences at different grade levels.

Grade	Mean performance score		Performance difference (terms)	t-value
	Male	Female		
Grade 4	23.71	24.58	<1	-6.015***
Grade 5	25.93	26.66	<1	-4.350***
Grade 6	27.49	28.76	<1	-6.959***
Form 1	23.93	24.38	1	-2.002**
Form 2	25.31	26.20	<1	-3.417**
Form 3	26.56	26.47	Nil	0.342

***significant at 1% **significant at 5%

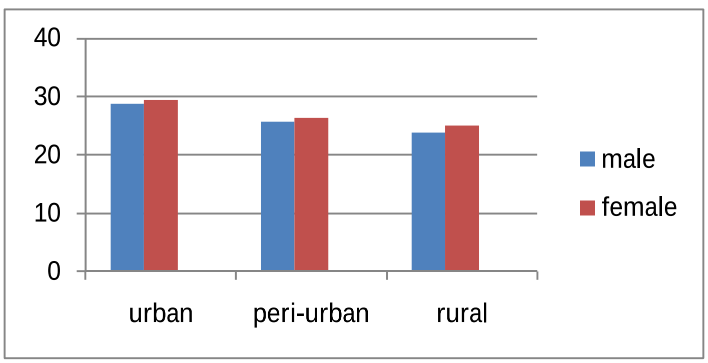

Figure 1. Gender differences by school location at primary level.

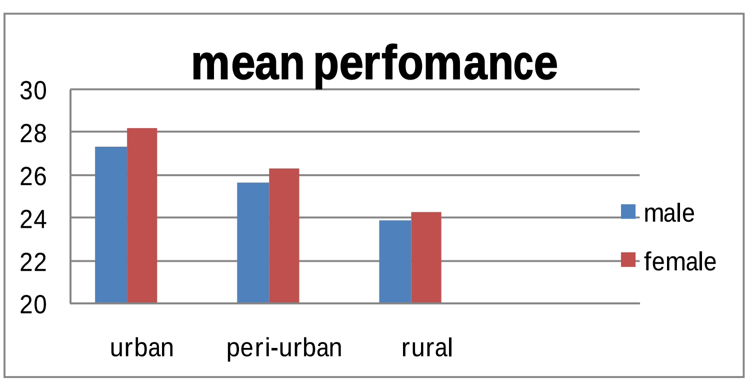

Figure 2. Gender differences by school location at secondary level.

country females are less disadvantaged in mathematics performance than their city counterparts, perhaps because in urban communities there may be more rigid sex role differentiation (Randhawa, 1988; Randhawa and Hunt, 1987 as quoted by Cox in Journal of Research in Rural Education, 2000). This difference was witnessed at both primary and secondary school levels and in peri-urban, rural and urban populations.

This confirms a number of previous studies which revealed that, contrary to popular stereotypes, girls are actually better than boys mathematically. For example, Pajares (1996) found that gifted girls outperformed gifted boys in mathematical problem solving. Other previous studies found notable differences when different locations were considered for instance Cox, (2000), found that rural Canadian girls outperformed boys in mathematics achievement while urban girls were outperformed by their male counterparts. On the contrary, in Nigeria, Awofala (2011) found significant differences in rural secondary school male and female students, with males performing better. Learner's attitudes can have an impact on how females and males solve mathematical problems. Many attitudinal differences, such as mathematics anxiety, confidence in mathematical ability, stereotype view of mathematics, perceptions of differential expectations and encouragement (Buchanan, 1987; Caplan and Caplan, 2005) can all affect how much a learner achieves in mathematics.

Consistent with the findings of Cox (2000), the present study finds rural students to be slightly disadvantaged compared with urban students. It is also possible that natural differential gender proportions in schools and not particularly in compulsory mathematics courses at the levels of schooling in the study may account for some of the observed differences. The inequality of opportunity for rural students is a plausible contributor to results reported here. Performance differences found may also have been caused by more limited access to resources and training for teachers in rural schools.

Male students are perhaps becoming the new underclass in Zimbabwean schools as charged by Messina (1995) as quoted in Cox (2000) in Australian schools and it could be argued that the under-enrolment of females in mathematics, particularly in advanced mathematics courses, is a well-recognized problem. however, over-enrolment by males in mathematics due to social pressures to do science related subjects is not usually a recognized problem, and less capable males equally pay the price in the form of statistically lowered grades.

Misguided parental pressure may define results on gender lines. Initiatives are in place to assist females, and these initiatives need to be further developed incorporating males in order not to produce a reverse skew against boys, particularly by finding ways to encourage girls to take the more specialised mathematics subjects.

Finally, the possible disadvantage for rural students which may still incorporate a gender bias militating against the girl child, needs to be more fully investigated to determine the persistence of the effect reported here. Training and resourcing initiatives need to be developed to overcome such rural -urban imbalances. Resourcing and training may be able to bring teachers and students from the rural areas to parity with their urban counterparts in external national examinations which have become highly competitive in the Zimbabwean case.

Conclusion

This study revealed clearly that there is a significant difference between boys and girls in terms of mathematics achievement. The discrepancy in performance measured on standardized achievement tests is tilted in favor of the girl child. Girls performed significantly better than boys regardless of location and grade.

Better mathematics performance was however witnessed in the urban areas than in rural areas and peri-urban areas for instance. These results contradict a number of studies in other contexts and hitherto assumptions which pointed towards boys outperforming girls in mathematics achievement.

This scenario in which girls outperformed boys could well be explained by a shift in attitudes resulting from the higher literacy rates prevailing in Zimbabwean context which may have made inroads in challenging stereotypes held that academia was a male domain and boys subsequently mathematically superior.

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ANNEXURES

Annex 1.0

Male versus female performances by location at primary level

Urban		Peri-urban		Difference(terms)	t-value
Male		Female			
Mean	Std dev	Mean	Std dev	Differences	
28.73 (n=1741)	5.254	26.34 (n=517)	4.677	2	11.95***
Female		Male			
29.41 (n=1849)	5.081	25.63 (n=546)	4.605	4	15.43***

Urban		Rural		Differences(in terms)	t-value
Male		Female			
Mean	Std dev	mean	Std dev		
28.73 (n=1741)	5.254	24.99 (n=3086)	4.471	4	26.71***
Female		Male			
29.41 (n=1849)	5.081	23.87 (n=3027)	4.528	6	7.39***

Peri-urban		Rural		Differences(in terms)	t-value
Male		Female			29.09***
Mean	Std dev	mean	Std dev	1	
25.63 (n=546)	4.605	24.99 (n=3086)	4.471		
female		male			
26.34 (n=517)	4.677	23.87 (n=3027)	4.528	2	3.48***

***significant at 1%, **significant at 5%

Annex 1.1

Male versus female performances by location at secondary level

Peri-urban		Rural		Differences(in terms)	t-value
Male		Female			9.14***
Mean	Std dev	mean	Std dev		
26.80(n=500)	7.692	24.24(n=2494)	5.649	3	
female		male			
27.64(n=472)	7.987	23.90(n=2270)	5.991	4	10.69***

Urban		Peri-urban		Differences(in terms)	t-value
Male		Female			0.67
Mean	Std dev	mean	Std dev		
27.35(n=896)	5.836	27.04(n=472)	7.997	<1	
female		male			
28.24(n=1016)	6.201	26.80(n=500)	7.692	1	5.66***

Urban		Rural		Differences(in terms)	t-value
Male		Female			11.96***
Mean	Std dev	mean	Std dev		
27.35(n=896)	5.836	24.24(n=249)	5.649	3	
female		male			
28.24(n=1016)	6.201	23.90(n=227)	5.991	4	18.08***

***significant at 1%, **significant at 5%