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Gender Based Patterns of Classroom Interactions and Pupils Attitude towards Mathematics among Secondary Schools Pupils in Mozambique

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Abstract

The present study intended to explore possible gender-based patterns of teacher-pupil interactions in mathematics classrooms and its effect on pupils' attitude towards mathematics. Data were gathered using an attitude scale and a classroom observation schedule and the study was carried out in a natural school environment following a quantitative research design methodology and it involved junior secondary school pupils and their mathematics teachers. The general result from this study showed gender based differences in attitudes towards mathematics and in the patterns of teacher-pupils interactions, with boys demonstrating more positive attitude and interacting more with their mathematics teacher than girls.

***Keywords**: **G**ender differences, attitude towards mathematics, classroom interactions.*

1. Introduction

The females' under-representation in formal education can be seen as an ancient problem, which was born with the common belief that females are not considered equally talented as males for working in mathematics. Although, according to [10], this finding was relative to a specific population and it could be extrapolated to a broader population since there is a worldwide convention that girls are not interested in participating in mathematics and its related-fields. Though, this aspect is of extreme importance and hence it is recognized that a strong mathematical background is a prerequisite to many career and job opportunities. Therefore, the aim of this study was to explore possible gender based differences in pupils' attitude towards mathematics and patterns of teacher-pupils interaction in mathematics classrooms. However, in other studies, as [6] and [7] it was noted inconsistent findings, and that gender differences in mathematics are related to teacher behavior and classroom climate. Thus, in addition [14], also argued that one component of the external influences, which may affect the development of gender related differences in mathematics would be the teacher influence on both students' internal motivational beliefs and on students' participation in classroom learning activities.

On one hand, [23] stated that the overall impression conveyed by the data from the study carried out in Australia, suggested that boys and girls were treated differently in Mathematics lessons. In fact, there have been other studies (e.g., [7], [6], [18], [25], [22] and [24]), indicating that males and females are not treated equally in the Mathematics classroom, with females being disadvantaged, as Mathematics teachers interact more with boys than with girls. Thus, compared with females, males have been found to receive more assistance and have their work monitored more often. The same authors underlined the evidence that teachers have interacted more frequently with boys than with girls. However, [12] argued that in USA the gender-differences in mathematics may be decreasing and that an intervention is a need for achieving equity in mathematics education. Meanwhile, there are other authors, (e.g., [17], [12], [14] and [13]), arguing that the effect of the way teacher interacts with their pupils, and therefore its influence on pupils' participation in classroom should be one of the components of the external influences, which may contribute to the development of gender differences in the learning of mathematics and in attitude towards mathematics.

Therefore, in a review of relevant research reports regarding the affective variables, some authors, as [26] and [23], noted that the pupils' decline in positive attitudes toward mathematics could be explained in part as a function of teacher supportiveness and the classroom environment. This role of the mathematics teachers was widely examined in others studies (e.g., [7], [8], [12] and [11]), and most of the results lead to the conclusion that students tend to attribute their feelings about mathematics to their identification with influential teachers or to their reactions to bad experiences for which they blame teachers. In fact, in a study by [17] examining the link between students' attitudes to mathematics and their perceptions of classroom environmental factors in co-educational schools found that teacher variables were stronger indicators of mathematics attitude for males than for females.

2. Material and Methods

The sample of this study consisted of 1221 junior secondary pupils (531 boys and 690 girls) of 9th and 10th grades and their mathematics teachers from 4 co-educational schools (2 private and 2 state schools) of Maputo City, the Capital of Mozambique. To gather data an Attitude Scale and a Classroom Observation Schedule were developed and used by the researcher based respectively on the "Modified Fennema-Sherman Mathematics Attitude Scale" - MAS, and the FIAC – Flanders Interaction Analysis Category, [30], and the "Brophy and Good Dyadic systems" for classroom observations [20]. The decision to use an attitude scale and observational methods is supported by the research methodology of previous studies, by [28] and [9], where these types of instruments have been used to carry out effective data collection. Statistical data analysis was performed using the "SPSS" for Windows and, in general these analyses considered gender and age group as the independent variables. Thus, in order to find out the possible gender patterns in the classroom interactions between the pupils and their mathematics teacher, a grid was developed by the researcher covering the most usual interactions that occur during a mathematics lesson in Mozambique which would be judged to involve individual pupil or the whole class.

3. Results

3.1 The Sample

The first result presented of this study relates to the characteristics of the sample used for the two components of the study, "Attitude" and "Interaction". The general sample consisted of 1221 pupils of whom 531 (43.5%) were boys and 690 (56.5%) were girls and their nine mathematics teachers (2 women and 7 men). These subjects were from four different co-educational schools (2 state and 2 non-state) and they were distributed in 33 classes of grades 9 and 10. The class sizes varied from 45 to 55 in the state schools and from 23 to 25 in the non-state schools. The pupils' age varied from 13 to 23 years of age in both types of schools. In state schools, the mean age was 17 years old for both, girls and boys, while in non-state schools it was 15 and 16 years old for girls and boys, respectively. Overall, only 28% of the participating pupils were in the appropriate age group (i.e. under 16 years of age) for schooling at their expected educational level. Table 1 displays the frequency distribution of the pupils by gender, school type, grade, and age group. From the many study, the 1221 subjects filled the MAS and only 672 were involved in the classroom observation study to explore the patterns of teacher-pupils classroom interactions, and among the number of pupils involved in the classroom observation, 287 (42.7%) were boys while 385 (57.3%) were girls.

Table 1: Total number of Pupils by School Type, Age Group, Grade and Gender

			Boy	Girl	Total
State	Younger	*Grade 9*	63	83	146
		Grade 10	25	36	71
		TOTAL	88	119	217
	Older	*Grade 9*	162	206	368
		Grade 10	176	236	412
		TOTAL	338	442	780
	All	*Grade 9*	225	289	514
		Grade 10	201	272	473
		TOTAL	426	561	987
Non-State	Younger	*Grade 9*	46	45	101
		Grade 10	11	35	46
		TOTAL	57	80	137
	Older	*Grade 9*	18	14	32
		Grade 10	30	35	65
		TOTAL	48	49	97
	All	*Grade 9*	64	59	123
		Grade 10	41	70	111
		TOTAL	105	129	234
All	Younger	*Grade 9*	109	128	237
		Grade 10	36	71	107
		TOTAL	145	199	344
	Older	*Grade 9*	180	220	400
		Grade 10	206	271	477
		TOTAL	386	491	877
	All	*Grade 9*	289	348	637
		Grade 10	242	342	584
		TOTAL	531	690	1221

The pupils' attitude, in the study, was measured by using a "Modified Fennema-Sherman Mathematics Attitude Scale" (MAS) covering four components of the affective domain that have been established in the literature as likely to be important aspects of pupils' attitudes toward mathematics. The items of the MAS were aggregated in 4 different sub-scales regarding pupils' perceptions about "pupils' Confidence in learning and performing well in mathematics tasks"; "mathematics Teacher Attitude towards the pupils"; "mathematics as a Male Domain" and the "Usefulness of mathematics". For each sub-scale half of the statements were positively worded while the remainders were negatively worded.

The MAS had an internal consistency of α=0.83 for the total sample, α= 0.79 for boys and α= 0.85 for girls, and according to [1], these values are regarded as good. Although, similar satisfactory results were found only for two of the sub-scales, "Confidence" and "Usefulness", since the other two sub-scales, the "Teacher Attitude" and "Male Domain" showed values below 0.70. And, in the attempt to explore possible gender based patterns of classroom interactions between mathematics teachers and their pupils an observation scheduled was constructed and used. A total of 3864 interactions were recorded in 344 lessons observed among Public and Private Interactions. Within this total number of the interactions recorded, 18% (687) involved the Mathematics teacher interacting with the class as a whole and thus, only the remaining 82% (3177 interactions) were analyzed for possible gender-based patterns of teacher-pupils interactions.

3.2 Pupils Attitudes towards Mathematics

In establishing whether statistically significant effects existed on pupils' attitude towards mathematics a four-way ANOVA was performed with gender, age group, grade and school type as the independent variables. In Table 2 a summary of the Four- way ANOVA's is provided. As can be seen, a significant main effect of gender was found for the MAS ($F_{1:1205}$=12.637; p<0.001) and the **Male Domain** sub-scale ($F_{1:1205}$=14.160; p<0.001). The others significant results noted were the main effect of school type ($F_{1:1205}$=22.792; p<0.001) and the interaction between gender and school type ($F_{1:1205}$=7.286; p<0.01), on **Confidence**. There were no significant main effects or interactions of the independent variables on the ratings of the **Teacher Attitude** and **Usefulness** sub-scales.

Table 2: Four-way ANOVA: Mathematics attitude scale and sub-scales scores by gender, age group, grade and school type

The Mathematics Attitude Scale		
	df	***F***
Gender	1:1205	12.637[b]
Age	1:1205	0.284
Grade	1:1205	1.347
School	1:1205	1.473
Gender x Age	1:1205	1.844
Gender x Grade	1:1205	0.191
Gender x School	1:1205	2.420
Age x Grade	1:1205	0.264
Age x School	1:1205	1.861
Grade x School	1:1205	1.445
Gender x Age x Grade	1:1205	0.339
Gender x Age x School	1:1205	1.613
Gender x Grade x School	1:1205	0.784
Age x Grade x School	1:1205	1.339
Gender x Age x Grade x School	1:1205	0.181
The Confidence Sub-Scale		
	df	***F***
Gender	1:1205	6.685
Age	1:1205	0.967
Grade	1:1205	0.926
School	1:1205	22.792[b]
Gender x Age	1:1205	0.289
Gender x Grade	1:1205	0.097
Gender x School	1:1205	7.268[a]
Age x Grade	1:1205	2.116
Age x School	1:1205	5.374
Grade x School	1:1205	0.118
Gender x Age x Grade	1:1205	5.801
Gender x Age x School	1:1205	1.206
Gender x Grade x School	1:1205	0.239
Age x Grade x School	1:1205	0.160
Gender x Age x Grade x School	1:1205	1.587
The Male Domain Sub-Scale		
	df	***F***
Gender	1:1205	14.160[b]
Age	1:1205	0.112
Grade	1:1205	0.144
School	1:1205	3.216
Gender x Age	1:1205	6.290
Gender x Grade	1:1205	0.219
Gender x School	1:1205	0.041
Age x Grade	1:1205	0.065
Age x School	1:1205	0.019
Grade x School	1:1205	0.221
Gender x Age x Grade	1:1205	1.244
Gender x Age x School	1:1205	1.145
Gender x Grade x School	1:1205	2.166
Age x Grade x School	1:1205	1.387
Gender x Age x Grade x School	1:1205	0.273
The Teacher's Attitude Sub-Scale		
	df	***F***
Gender	1:1205	2.554
Age	1:1205	1.211
Grade	1:1205	0.043
School	1:1205	6.411
Gender x Age	1:1205	1.174
Gender x Grade	1:1205	0.243
Gender x School	1:1205	0.142
Age x Grade	1:1205	1.830
Age x School	1:1205	0.243
Grade x School	1:1205	0.003
Gender x Age x Grade	1:1205	0.535
Gender x Age x School	1:1205	0.001

Gender x Grade x School	1:1205	0.071
Age x Grade x School	1:1205	0.009
Gender x Age x Grade x School	1:1205	0.031
The Usefulness Sub-Scale		
	df	***F***
Gender	1:1205	0.377
Age	1:1205	1.680
Grade	1:1205	1.203
School	1:1205	1.027
Gender x Age	1:1205	0.478
Gender x Grade	1:1205	0.846
Gender x School	1:1205	1.668
Age x Grade	1:1205	1.053
Age x School	1:1205	0.103
Grade x School	1:1205	3.268
Gender x Age x Grade	1:1205	0.067
Gender x Age x School	1:1205	0.383
Gender x Grade x School	1:1205	0.876
Age x Grade x School	1:1205	0.529
Gender x Age x Grade x School	1:1205	1.642
a) p<0.01; b) p<0.001		

In establishing whether statistically significant gender differences existed in pupils' attitude towards mathematics the analysis, (see Table 3), revealed that there were statistically significant differences between the patterns of attitudes toward mathematics expressed by boy and girl pupils in which boys were found to be rating their attitude more positively than girls (t1:1220=6.889; p<0.001). This result is partially supportive of different findings (e.g. [15] and [23]), where females have been noted to have less positive attitudes toward mathematics and that these differences increase as pupils' progress in school. Although, it contradicts the findings from others studies that reported no serious differences were detected in the attitudes of boys and girls toward mathematics since both boys and girls exhibited the same enthusiasm or faced the same difficulties on different topics, ([7], [8]). Perhaps the apparent contradiction between these sets of findings and those from the present study could be clarified by the gender comparison in the different sub-scales and hence the general attitude may be masked by the depth of the differences in each sub-scale.

For instance, it is evident that, according to authors as [6], [7], [15], [2], [29] and [27], confidence in learning mathematics has consistently been found as an important component of gender-related differences. And, the results of this study are supportive in that boys were more confident about working in mathematics than girls. Although gender differences in perceptions of mathematics as a Male Domain may not be as significant as it may have been when the original scale was constructed, they are persistent and still evident in current work. In this study, girls did not strongly stereotype mathematics as a Male Domain they believe much more than boys that mathematics is more appropriate for males than for females and this was particularly evident in the younger pupils. In this sub-scale, low scores indicate that mathematics is not a Male Domain. Thus, the results on the Male Domain sub-scale are similar to those reported in other research carried out in different countries and involving different educational levels (e.g. [19] and [27]). And, regarding the mathematics Teacher's Attitude sub-scale, in general, boys rated their perception more positively than girls on how their mathematics teachers feel about them as learners of mathematics. This was particularly evident within the older pupils, in this study. This finding reinforces the argument by some authors who state that mathematics teacher's attitude is frequently invoked to explain gender differences in pupil participation in post-compulsory mathematics courses ([7], [8], [16], [5], [13], [21] and [11]).

Table 3: Means, standard deviations and the t-values of the Confidence sub-scale by gender, school type, grade and age group

		Boys		*Girls*		*t*
		Mean	*SD*	*Mean*	*SD*	
Confidence	Younger	3.43	0.74	3.21	0.59	3.120[a]
	Older	3.51	0.70	3.23	0.56	6.523[b]
	Total	3.49	0.71	3.22	0.57	7.185[b]
Male Domain	Younger	2.08	1.01	1.68	0.64	4.515[b]
	Older	2.01	0.94	1.85	0.81	2.641[a]
	Total	2.03	0.96	1.80	0.77	4.567[b]
Teacher	Younger	4.01	0.74	3.93	0.75	0.889
	Older	4.04	0.75	3.88	0.76	3.052[a]
	Total	4.03	0.74	3.90	0.76	3.063[a]
Usefulness	Younger	4.29	0.67	4.25	0.56	0.530
	Older	4.17	0.70	4.16	0.72	0.191
	Total	4.20	0.69	4.19	0.68	0.377
MAS	Younger	3.45	0.43	3.27	0.33	4.489[b]
	Older	3.43	0.42	3.28	0.39	5.471[b]
	Total	3.44	0.42	3.28	0.37	6.889[b]
a) p< 0.01; b) p< 0.001						

3.3 Pupils' Perceived Confidence in Learning Mathematics

A total of 11 items constituted the **Confidence** sub-scale which purported to measure pupils' **confidence** in their ability to learn and to perform well on mathematics tasks. The pupils mean ratings scores are displayed in Table 3 with respect to gender, grade, school and age groups. The pair-wise differences on gender indicated that in general boys (3.49) were shown to be more confident in working in mathematics than girls (3.22). This difference was found to be statistically significant (t_{1220}=7.185; p<0.001).

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Even when the sample was compared within grade level, the gender differences still favored the boys in both the younger and older age groups in grade 9 significantly (younger age group: t_{236}=2.821; p<0.01 and older age group (t_{399}=3.165; p<0.01). While in grade 10 only the gender differences favoring boys in the older age group, were found to be statistically significant (t_{476}=6.052; p<0.001). The state school pupils showed a significant gender difference in mathematics **confidence** within the age group. Here, this difference was in favor of boys in both the younger pupils (t_{216}=2.769; p<0.01), and the older pupils (t_{779}=6.981; p<0.001). In both grades significant gender differences were also found between the means of the older pupils (grade 9: t_{367}=3.760; p<0.001 and grade 10: t_{411}=6.161; p<0.001). None of the mean differences in the non-state school pupils displayed statistically significant differences based on gender.

3.4 Pupils' Perceptions of Mathematics as a Male Domain

In an attempt to measure the degree to which pupils see mathematics as a **Male Domain** or gender neutral, a sub-scale comprising 11 items' was used. The **Male Domain** sub-scale scores have been reversed so that a low score implies that mathematics was more stereotyped as a **Male Domain** and thus, a high score indicates less stereotyping or gender neutral. Thus, in Table 3 presents the means and standard deviations of the pupils' scores by gender, school type, grade and age group.

The pair-wise differences on gender yielded that overall boys scored higher than did girls and this difference between boys and girls was statistically significant (t_{1220}=4.567; p<0.001). These results were also consistent in both grades (9 and 10) where boys also scored significantly higher than did girls (grade 9: t_{636}=2.887; p<0.01 and grade 10: t_{583}=3.596; p<0.001).

Further pair-wise differences on gender yielded that in general, when considering the school type the boys were still found to have higher scores than the girls, particularly in the state schools (t_{986}=3.929; p<0.001). However, when grade levels were taken into account within each school type, the differences favouring boys were found to be statistically significant only in grade 10 of the state schools (t_{472}=3.645; p<0.001) and in grade 9 of the non-state schools (t_{122}=2.808; p<0.01).

In addition, when the age group was accounted for in the gender comparison, it was found that overall, in both age groups, boys also scored significantly higher than did the girls (t_{343}=4.515; p<0.001 for the younger group and t_{876}=2.641; p<0.01 for the older group), confirming that girls more than boys stereotyped mathematics as a **Male Domain**. However, only within the younger age groups of the two grades were the gender-based differences statistically significant (t_{236}=2.945; p<0.01 in grade 9 and t_{106}=3.758; p<0.001 in grade 10). This situation was also evident when the comparison was done by school type, with statistical significance particularly in the state schools for both age groups (younger age group: t_{216}=2.872; p<0.01; older age group: t_{779}=2.976; p<0.01).

3.5 Pupils' Perceptions of Mathematics' Teacher Attitude

Table 3 gives the mean and standard deviation of the data obtained by using the scores of the 9 items which comprised the **Teacher Attitude** sub-scale that measures the pupils' perception of how their teachers feel about them as learners of mathematics. The analysis of the results of the mean scores comparison on the **Teacher Attitude** sub-scale showed in general, gender related differences. Indeed, boys more than girls rated their perception, on how their mathematics teachers feel about them as learners of mathematics, significantly more positively than girls (t_{1220}=3.063; p<0.01). This was also evident when this comparison was done within the older group pupils, where boys were also found to exceed the girls on the perception of the **Teacher Attitude** sub-scale with the difference being statistically significant at p<0.01, (t_{876}=3.052). However, when the sample was aggregated by school type, an interesting result was found. No statistically significant difference was yielded by any of these gender pair-wise comparisons in both types of schools.

3.6 Pupils' Perception of Mathematics' Usefulness

The measure of the degree of the **Usefulness** of mathematics considering its application in daily life was done using a sub-scale comprising 12 items out of the 43 items of the **MAS**. The means and standard deviation for the **Usefulness** sub-scale is given in Table 3. In general, the Mozambican lower secondary school pupils, to a great extent, rated the **Usefulness** of mathematics, as being important, as the average rating values were more than 4 on the 5-point-rating-scale for boys as well as for girls.

A further examination of the gender pair-wise differences showed that boys and girls rated mathematics **Usefulness** equally across the different school types, grade levels and age groups. Though, it was in this sub-scale that girls'

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ratings surpassed in various cases the scores of boys but this was not significant. This was particularly evident in the non-state schools, yet none of these differences were statistically significant.

3.7 The Patterns of Teacher-Pupils Interactions

A total of 344 lessons each of about 45 minutes were observed during the official school period for secondary education. The classroom interactions made distinction between **Public** and **Private** Interactions, **Modes of Initiation** of the interactions (teacher-initiated or pupil-initiated), **Modes of Teacher-Questioning** (nomination or selecting a volunteer), **Quality of Pupil Answers** and **Quality of the Teacher Feedback**. Thus, **Public** interactions are those with the mathematics teacher working with individual pupils during lessons, with the rest of the class as spectators, while the **Private** interactions included the types of interactions involving the mathematics teacher and a specific pupil with no involvement of any other pupil. In the four co-educational schools (two-state and two-non-state schools) a total of 3864 interactions were recorded in the 344 observed lessons. However, within the total number of interactions recorded, 17.8% (687) involved the mathematics teacher interacting with the class as a whole and thus, only the remaining 3177 interactions were analyzed for possible gender differences in the classroom interactions.

Patterns of Classroom Interactions based on Gender were analyzed and the frequencies and mean number of teacher-individual pupil interactions, by pupils' gender, grade level and type of school, are summarized in Tables 4 and 5 for 9th and 10th grades respectively. First of all, these interactions could be categorized as **Public** or **Private** Interactions. The **Public** interactions were then split by the content involved in the interaction, (mathematics content or non-mathematics content), while in the case of **Private** interactions it was impossible and not ethical to ascertain whether they involved mathematics content or not. Here and more generally, the mean number of interactions was obtained by dividing the total number of teacher-pupil interactions in each gender-group by the total number of pupils of each group (boys or girls).

In Tables 4 and 5, it can be seen that in general boys interact in public much more with their mathematics teacher than girls and, this boy domination can be seen as a consequence of the higher proportion of teacher-boy interactions on mathematics content. Similarly, [23] found that boys were involved in significantly more public interactions with their teachers than girls, and in particular, in more interactions related to the subject content. It appears that, as [11] argued, the climate in mathematics classrooms is often more favorable to boys' learning than to girls' learning. These findings reinforce the view that males and females are not treated equally in the mathematics classroom, ([5]; [22]; [24]; [25]; [3]; [18]). In general, in grade 9, boys could expect to interact more frequently with their mathematics teacher ($b_i/b=3.5$), in **public**, than girls ($g_i/g=2.5$) and the differences were found to be statistically significant (X_1^2 =27.838; $p<0.001$). Similarly in grade 10 (see Table 5), boys reached a higher frequency of interactions of $b_i/b=4.5$ than girls who had on average $g_i/g=3.6$ and the chi-square value yielded a statistical significance at $p<0.001$ (X_1^2 =15.419).

However, when comparing the classroom interactions involving teacher and pupils in each school type it was found that frequencies of gender interactions with the teacher were different in the two school types. These differences in frequencies were larger in state schools than the non-state schools. Within the state schools, pupils' group, in grade 9 (see Table 4), boys on average ($b_i/b=2.9$) had significantly more **public** interactions with the mathematics teacher than had girls $g_i/g=1.9$).

Table 4: GRADE 9 - Frequencies and Mean Number of Interactions by Type, Pupil's Gender, School Type and Grade

			Boy (118)		***Girl (149)***		X_1^2
GRADE 9	State School		b_i	b_i/b	g_i	g_i/g	
		Public	336	2.85	279	1.87	27.176^b
		Math Cont	281	2.38	220	1.48	28.733^b
		Non Math Cont	55	0.47	59	0.40	*0.758*
		Private	5	0.04	8	0.05	*0.173*
		TOTAL	341	2.89	287	1.92	-
	Non-State School		***Boy (40)***		***Girl (41)***		X_1^2
			b_i	b_i/b	g_i	g_i/g	
		Public	211	5.28	194	4.73	*1.195*
		Math Cont	194	4.85	185	4.51	*0.494*
		Non Math Cont	17	0.43	9	0.22	*2.663*
		Private	68	1.70	82	2.00	*0.984*
		TOTAL	279	6.97	276	6.73	-
	ALL		***Boy (158)***		***Girl (190)***		X_1^2
			b_i	b_i/b	g_i	g_i/g	
		Public	547	3.46	473	2.49	27.838^b
		Math Cont	475	3.01	405	2.13	26.103^b
		Non Math Cont	72	0.46	68	0.38	*2.051*
		Private	73	0.46	90	0.47	*0.025*
		TOTAL	620	3.92	563	2.96	-

Math Cont=Mathematics Content's Interaction; ***Non Math Cont***=Non-Mathematics Content's Interaction; $\mathbf{b_i}$=Number of boys' interactions; $\mathbf{g_i}$ = Number of girls' interactions; **b**=Number of boys; **g**=Number of girls. a) p<0.01; b) p<0.001

Table 5: GRADE 10 - Frequencies and Mean Number of Interactions by Type, Pupil's Gender, School Type and Grade

			Boy (101)		***Girl (152)***		X_1^2
			b_i	b_i/b	g_i	g_i/g	
GRADE 10	State School	**Public**	407	4.03	444	2.92	*22.173*^{b}
		Math Cont	385	3.81	424	2.79	*19.836*^{b}
		Non Math Cont	22	0.22	20	0.13	*2.719*
		Private	55	0.55	115	2.21	*4.060*
		TOTAL	462	4.57	559	3.68	-
			Boy (28)		***Girl (43)***		X_1^2
			b_i	b_i/b	g_i	g_i/g	
	Non-State School	**Public**	168	6.00	253	5.88	*0.039*
		Math Cont	146	5.21	220	5.12	*0.032*
		Non Math Cont	22	0.79	33	0.77	*0.007*
		Private	151	5.39	401	9.33	*33.735*^{b}
		TOTAL	319	11.39	654	15.21	-
			Boy (129)		***Girl (195)***		X_1^2
			b_i	b_i/b	g_i	g_i/g	
	ALL	**Public**	575	4.46	697	3.57	*15.419*^{b}
		Math Cont	531	4.12	644	3.30	*14.175*^{b}
		Non Math Cont	44	0.34	53	0.27	*1.245*
		Private	206	1.60	516	2.65	*38.357*^{b}
		TOTAL	781	6.05	1213	6.22	-

Math Cont=Mathematics Content's Interaction; ***Non Math Cont***=Non-Mathematics Content's Interaction; $\mathbf{b_i}$=Number of boys' interactions; $\mathbf{g_i}$ = Number of girls' interactions; **b**=Number of boys; **g**=Number of girls. a) p<0.01; b) p<0.001

In grade 9 of the state schools (Table 4), there was a significant gender difference in favour of boys (b_i/b=2.4) compared to the girls (g_i/g=1.5) in **public** interactions covering mathematics content (X_1^2 =28.733; p<0.001). Meanwhile, in non-state schools boys and girls were found to interact similarly with their mathematics teachers in all the considered types of interactions. Gender-based difference in interacting with the mathematics teacher was also seen in grade 10. In state schools boys (b_i/b=3.8) had significantly more chance to have mathematics content interactions (X_1^2 =19.836; p<0.001) than had girls (g_i/g=2.8). While in non-state schools the girls' advantage (g_i/g=9.3) was seen in receiving significantly more of the **private** interactions (X_1^2 =33.735; p<0.001) than boys (b_i/b=5.4). On the other hand, in grade 10 the **private** interactions differentiate between teacher- boy and teacher-girl interactions. Within this type of interaction it was found that girls (g_i/g=2.6) could be expected to interact much more with their mathematics teacher than boys (b_i/b=1.6), yielding a X_1^2 =38.357, with a statistical significance of p< 0.001. In grade 10 (Table 5) the results were consistent with the boys having a greater average frequency (b_i/b=4.0), whereas the girls average frequency was lower (g_i/g=2.9). All these differences were found to be highly significant (grade 9: X_1^2 =27.176; p<0.001 and grade 10: X_1^2 =22.173; p<0.001), but, in non-state schools, boys and girls had similar frequencies of the **public** interactions. However, in the expectation of interacting with their mathematics teacher on mathematics content in grade 9, it was also seen to the boys' advantage (b_i/b=3.0) compared to the girls (g_i/g=2.1), and this difference in frequency was statistically significant (X_1^2 =26.103; p< 0.001).

In grade 10 (Table 5), the mathematics content interactions could be expected to occur involving mostly the mathematics teacher and the boy pupils (b_i/b=4.1) when compared with the mathematics teacher and the girl pupils (g_i/g=3.3). This difference was also found to be statistically significant (X_1^2 =14.175; p< 0.001).

3.8 Mathematics Classroom Interactions and Pupils' Attitude

When the patterns of the mathematics teacher-individual pupil interactions were related with the pupils' categories attitude, it was seen that girls with neutral attitude towards mathematics, in grade 9, were found to have proportionally more Private interactions than all the other groups. This group was not represented within the volunteers selected in grade 9 and, within the pupils with Private interactions in grade 10. On the other hand, boys who had negative attitudes toward mathematics did not have Private interactions with the mathematics teachers in both grades 9 and 10 and they were only nominated in grade 10 and selected within the volunteers in grade 9. Comparing boys and girls with positive attitudes toward mathematics it was found that the Private interaction percentage in grade 9 differed from the others hence only here, boys reached higher percentage than girls. Even the nomination by the mathematics teacher presented higher

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percentage of girls with a positive attitude than boys. Then, girls with neutral attitude towards mathematics, in grade 9, were found to have proportionally more Private interactions than all the other groups. This group was not represented within the volunteers selected in grade 9 and, within the pupils with Private interactions in grade 10. Perhaps from the proportionate difference in Private interactions it could be inferred that these pupils are unsure about their mathematical abilities, and that the teacher then approaches them in a more co-operative way by means of Private interactions. In addition, mathematics teacher nominated and selected within the volunteers more girls than boys, regardless of the pupils' attitude towards mathematics in grade 10. However, in grade 9, the teacher selected more volunteer boys with a negative or neutral attitude than girls with similar attitudes, while within the pupils' group of positive attitude more girls than boys were selected. The teachers' nomination also differentiated boys and girls in grade 9 since girls more than boys, within all the attitude groups were nominated. This shows that the patterns of classroom interactions are a direct consequence of teacher's attitude and influenced by the pupils' attitude towards mathematics. Clearly, the attitude of teachers was of great importance and these results give support to the findings of [4] who stated the teaching methods used in mathematics contribute to create barriers to female participation. On the other hand, the same results confirmed the argument that teachers have interacted more frequently with pupils for whom they held positive expectations. To this conclusion also arrived [22] and [18] amongst others.

4. Conclusions and Recommendations

This study aimed to find out the influence of certain school-based factors on gender differences in participation in mathematics by means of an attitude scale and an observation scheduled. To this end aimed to explore possible gender-based patterns of pupils' attitudes towards mathematics and gender-based patterns of classroom interactions between teachers and pupils occurring in the secondary schools mathematics lessons in Mozambique, and that is there any relationship between the classroom interactions and the mathematics attitudes towards mathematics among Mozambican secondary school pupils.

Thus, it was evident that there are gender differences in pupils' attitudes toward mathematics and boys were found to rate themselves with a more positive attitude than girls. Important components of these differences were the pupils' **confidence** in working in mathematics and the perception of mathematics as a **male domain** since it was in these attitude sub-scales that the pupils significantly differed by gender.. Although both boys and girls rated as positive, but not to a great extent, boys showed to be more confident than girls. Similarly, boys admitted less than girls, that mathematics is a **male domain**. **Teacher attitude** and **usefulness** sub-scales did not show gender differences in pupils' attitudes, boys and girls rated them similarly. On the other hand, patterns in classroom interactions were clearly affected by the gender differences in **confidence** in working in mathematics. This conclusion emerged particularly from the differences observed in being selected from within the volunteers. More than for girls, boys were selected by their mathematics teacher to answer at the desk as well as on the board. This is of interest since, if no girls were volunteers, mathematics teachers did not select girls in an attempt to maintain a gender equity. Therefore, the pupils' **confidence** in performing well in mathematics contributed to the existence of patterns of interactions favoring boys. Thus, it was concluded that: (1) albeit gender differences are small, they exist in the patterns of mathematics classroom interactions and attitude towards mathematics; (2) the gender differences in attitudes toward mathematics and classroom interactions by themselves are not large enough to justify the gender disparities that exist in the pupil's participation and career choice involving mathematics; (3) teacher attitude may have contributed to the gender differences observed even in the patterns of classroom interactions; (4) other school and socio-cultural factors might play a role in creating or reducing gender differences.

Regarding the classroom observation the interactions showed the existence of patterns based on gender with boys having more interactions, particularly those involving mathematics content, with the mathematics teacher, and being selected more frequently within the volunteers than were girls. However, the girls more frequently answered the questions correctly when they were asked directly by the teacher or when volunteers were called for, and also interacted one-on-one with the teachers more frequently than did the boys. The teacher's feedback also presented a gender-related difference since when a partially correct answer or incomplete solution was presented; the boys were given the correct answer or helped more than the girls. The girls were more likely to have the question repeated. An inadequate response yielded the boys being given the solution, and the girls having the question repeated more frequently. Thus, it is possible to conclude that the mathematics classroom interactions are influenced by the teacher's behavior and, the way in which the interactions occur are likely to promote more active participation from boys than from girls. On one hand, as the study was limited to explore the relationship between pupils' attitudes toward mathematics and classroom interactions, it would be beneficial in to extend the data to include a self-reported attitude measure on pupils' attitudes toward mathematics of these pupils for parents and school staff. The current study also did not investigate the out of school factors that may have exerted an influence on pupils' attitudes toward mathematics and participation in mathematics classroom lessons. It must also be examined how these socio-cultural conditions affect the educational environment of the pupil as well as affect the personal belief system of each learner taking into account the differences based on gender.

Thus, if girls will not spend time in making an effort in studying mathematics, and if they do not have sufficient time to do tasks which they regard as essential for females, if the society regards the promotion of a greater participation of women in the professions that require a strong background in mathematics then, the mathematics' teachers must be aware of gender issues, particularly: (1) That mathematics is useful in the real world; (2) That a gender neutral domain is required for successful teaching of mathematics to both genders; (3) That the girls are equally talented as boys with a similar potential for learning mathematics.

Naturally females faced several obstacles, among them the fact that the teaching approaches are teacher-centered promoting a competitive climate, which is not conducive to female higher performance and they have few female role models since even their teachers are predominantly male. It is imperative therefore that any strategy designed to produce gender equity in mathematics and related fields should focus not only on encouraging more females pupils to take mathematics, but also to promote classroom active learning (student-centered approaches) and by recruiting training and retraining more female educators.

The following strategies should serve as recommendations from this study to contribute to the reduction of the gender bias observed, through the improvement of the teaching/learning approaches and for guiding further research: (1) Promote short in-service teacher training courses to modernize teaching approaches, (active learning approaches/co-operative climate); (2) Create female role models in the education system by attracting more females to activities mostly for science subjects since in Mozambique there are a small number of women mathematics and science teachers who can serve as these role models; (3) Involve society in the attempts to find the solutions for the low participation of girls especially in the mathematics field; (4) Promote extra-curricular activities on the evident applicability of mathematics in the real world; (5) A qualitative study should also be done to explore potential causes of the observed gender differences analyzing classroom interactions, teacher guides and pupil textbooks for gender bias and other extra-school societal variables; (6) An in depth analysis should be done on the subjects and courses girls take and those they avoid, at the upper secondary level, especially with reference to mathematics and its related fields; and (7) Explore the attitudes of pupils, teachers, parents, curriculum developers and other education officials toward gender issues with a view to sensitization.

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