CHAPTER 7

THE EFFECT OF GENDER ON MATHEMATICS LEARNING

7.1 INTRODUCTION

This chapter explores the influences that gender may play on the mathematics achievement of the student. Gender is an important aspect of human relationship that cannot be ignored. It is an undisputable fact that women’s education plays a pivotal role in reformation and progress of a society. At the end of five decades of planned efforts to gear education towards development and to bring about equality of opportunity in and through education in India, the achievement has been impressive in parts but nevertheless inadequate and uneven. (Ravindra G, Basavvy D, Basti B C, 2004). Although substantial progress has been made in the direction of women’s education much remains to be done. The education of women is an instrument of liberation not only of women but of society as a whole and is a fundamental right for all. This right is also articulated clearly in Article 26 of the Universal Declaration of Human Rights (1948). Several documents of GOI in the last decade speak about inclusive education keeping in view the deprived class including women. A right based approach to education has gathered pace in recent years resulting in the recent The Right of Children to Free and Compulsory Education Act (2009). Yet, despite significant progress, the girls are still less educated and more likely to be illiterate than boys. The national average for male and female is 75.96 and 54.28, respectively. Gender equality, including education, is a condition for development and awareness of the gender dimension and action to promote gender equality has grown at the instructional level.
Indeed, after decades of intense debate, the world has reached consensus that no country’s development can be judged satisfactory if women do not fully participate in community life, in society and in work. This consensus was reaffirmed at several global conferences such as the Fourth World Conference on Women in Beijing (1995), the World Summit for Children (1990) and in Education, the World Conference on Education for All in Jomlien (1990) and the World Education Forum in Dakar (2002).

In particular with reference to mathematics education it is seen that issues related to gender and mathematics are complex. During the years between 1970 and 1990, there were probably more research studies published concerned with gender and mathematics than in any other area (Leder, 1996) Gender differences in learning mathematics cannot be explained in a simplified manner because there is the multiplicity of forces and environments that operate apart from gender which influences a child’s learning of mathematics Gender differences in mathematics may vary due to socioeconomic status and ethnicity, school environment, the mind-set of the teacher among other things According to Albert Bandura’s (1977) persistence theory self-efficacy is positively related to persistence. In other words persistence on a mathematics problem in spite of frustrations is more likely to lead to a solution/success (Brown, Lent & Larkin, 1989; Schunk, 1985). Low self efficacy in females has been attributed to low parental expectancies and sexual stereotyping in the attitudes of teachers and male students in school.

Gender differences remain a prime area of research in mathematics education with studies being carried on all over the world. Turner, R. (1994) investigates sex differences of first year secondary school students in mathematical performance in Wuhan, a central city of China. The study focuses on three mathematical areas: logic, space and numeracy. Hanson, Katherine(1992), explored girls’ learning styles, attitudes,
and behaviors in math classes highlighting the importance of analyzing the curriculum and attitudes of teachers when attempting to understand girls' relation to math.

Mathematics tends to be regarded as a masculine domain. The literature in gender studies suggests that society as whole believes that females are less mathematically capable than men (Aiken, 1974; Burton, 1979; Fenemma & Sherman, 1977, 1978). The findings were also not different for gifted girls (Benbow & Stanley, 1980; Cramer, 1989; Eccles, 1985). Traditional attitudes which associate formal computational abilities with the male sex deepen such failure in mathematics for girls by way of not creating self-fulfilling expectations. Girls have lower expectations for themselves in mathematics than boys, and that girls believe they do not have mathematical ability. When girls do poorly in mathematics, they attribute their poor performance to their inability to do mathematics. Barriers faced by girls include teachers, parents, and society's impact on girls' attitudes and perceptions, achievement and performance, course enrollment and participation, and career interests and aspirations (Dickens and Cornell, 1993, Hanson, 1992, Clewell B, 1991).

Classroom research also indicates a fairly systematic devaluation of girls as incapable of mastering mathematics, even when they perform reasonably well at verbal as well as cognitive tasks in mathematics. It has been seen that teachers tend to address boys more than girls, which feeds into the construction of the normative mathematics learner as male. Also, when instructional decisions are in teachers’ hands, their gendered constructions colour the mathematical learning strategies of girls and boys, with the latter using more invented strategies for problem-solving, which reflects greater conceptual understanding (Fennemma E, 2000). The Fennema-Sherman studies (Fennema & Sherman, 1977, 1978, Sherman and Fennema 1977) sponsored by the
National Science Foundation and published in the mid 1970s, documented sex-related differences in achievement and participation in Grades 6 to 12.

Studies have shown that teachers tend to attribute boys’ mathematical ‘success’ more to ability, and girls’ success more to effort (Weisbeck, L, 1992) Thus teachers' critical role in girls' success in math and science cannot be underestimated. It suggests that girls' low participation and their negative attitudes towards math and science are greatly affected by teachers' attitudes. Classroom discourses also give some indication of how the ‘masculinising’ of mathematics occurs, and the profound influence of gender ideologies in patterning notions of academic competence in school (Manjrekar, N, 2001).

Significant research was done by Eccles (1985), Wise (1985), Stanley (1980) and many others regarding the gender disparity. The focus of research was on the attitudes such as the perception of mathematics as a male domain, sex differences in mathematical abilities, career choices and access to role models. Research has also indicated that middle school and high school girls have positive attitudes toward school but negative attitudes toward mathematics I is also noticed that girls' positive attitudes towards mathematics decline as they grow older. Initially girls have more positive attitudes towards math than boys do, but as they continue in school, girls' attitudes become more negative. (Gill J, 1994, Swetman D, 1995). This may explain why gender differences favouring males are more in higher classes than in lower classes at school level. (Willingham and Cole, 1997; Cleary, 1992)

Three major studies undertaken in the National Council of Educational Research and Training (NCERT), involving several states, examined achievements of primary school education. Kulkarni (1970) conducted a study at three levels of education, i.e., at the end of primary, middle and secondary stage showed that with few
exceptions boys achieved higher than girls. Dave,(1988) observed that students differ in their achievement in mathematics and language.

Research on gender and mathematics has provided a powerful scientific discourse during the past three decades. The traditional results of lower achievement in cases of girls in mathematics have been challenged in recent times. Prevalent social attitudes are emerging which do not see girls as incapable of mathematics. A study by Tsui Ming(2008) examines the relationship between gender and mathematics achievement among students in China and the United States, with an emphasis on the gender gap among mathematically talented students. The results show that in neither the U.S. nor China are there gender differences in eighth grade math-achievement test scores. Researchers in South Africa found no sex differences in mathematics achievement in the university students majoring in mathematics. (Cherian V. I , Siweya J. 1996). Other recent studies have showed that this gap has declined (Barker, 1997; Hyde, Fennema, & Lamon, 1990; Knodel, 1997). And some other studies have shown no gender differences in mathematics achievement. Bronholt, Goodnow, and Conney (1994) reported no significant differences between male and female high school students in mathematics achievement.

Whatever the case maybe, the importance of a mathematical basis for all students lies in the fact that today the society is becoming more and more technological. This impact can be seen not only in engineering and science but also in diverse areas like agriculture, information technology, biology, healthcare, advertising and manufacturing. Without learning mathematics, one cannot choose to pursue graduate study in many fields, change careers, or do many other things. Not all people will choose to take up careers where the knowledge of mathematics is essential, but they should have the option to make that choice.
Against the background of demographic implication and the complex ground realities of Indian scene, creation of necessary structures which could empower women and make education an instrument of women's equality is a vital part of the goal of education for all.

The paper reports on the findings of a comparative study between the groups of students divided on the basis of their gender. The combined scores of the students were examined. Also the perceptions of the students regarding mathematics as well as their future plans were also investigated.

### 7.2 DATA

For class IX the number of boys in the sample was 163 and the number of girls in the sample was 127. For class VII the number of boys in the sample was 155 and the number of girls in the sample was 135. The combined scores of the tests conducted were examined.

### 7.3 STATISTICAL ANALYSIS

The data was entered into a SPSS spreadsheet and was analysed accordingly. The mean and standard deviation of the combined scores were calculated, t-test and ANOVA has been used to test the variance in the mean of the combined score for the different classes based on gender as well as other groupings. The combined score of the students of classes VII and IX have been taken as the dependent variables.

The group sizes for the samples were unequal. Thus the independent sample t-test was conducted to find the differences in means of test scores between the two groups with the following result.
The results of both classes IX and VII were of a similar nature. The test was a large sample t-test and for both cases the t value was less than the critical value of t (1.96) at 5% level of confidence. This implied that the null hypothesis should be accepted in both the cases and there was no significant difference in the means of the two groups for both class IX and class VII. This leads to the implication that the gender of the student did not affect the combined score of the students for the sample under investigation.

In order to get a more detailed study the above two groups were further subdivided and ANOVA was performed. The subdivided groups were
• Urban boys
• Rural boys
• Urban girls
• Rural girls

Variation of combined weighted scores (Mean+SD, count) (Mathematical achievement, concept and ability) of students of various schools of Bongaigaon district were carried out in keeping with the above subgroups. Values having different superscripts (a,b,) differ significantly (P<0.05) between groups/levels in a class.

<table>
<thead>
<tr>
<th>Gender-Area Group</th>
<th>Urban Boys</th>
<th>Rural Boys</th>
<th>Urban Girls</th>
<th>Rural girls</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class</strong></td>
<td>Mean+SD</td>
<td>±</td>
<td>Mean+SD</td>
<td>±</td>
<td></td>
</tr>
<tr>
<td>VII</td>
<td>33.90 ± 14.36</td>
<td>23.27 ± 11.43</td>
<td>31.23 ± 12.81</td>
<td>22.58 ± 11.48</td>
<td>13.674 **</td>
</tr>
<tr>
<td>N 81</td>
<td>74</td>
<td>89</td>
<td>46</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IX</td>
<td>39.04 ± 15.91</td>
<td>23.11 ± 13.03</td>
<td>34.73 ± 16.43</td>
<td>23.19 ± 12.47</td>
<td>22.300 **</td>
</tr>
<tr>
<td>N 85</td>
<td>78</td>
<td>75</td>
<td>52</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TABLE 7.2 Mean scores of students divided on basis of gender-area

Figure 7.2 Mean scores by gender-area group

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Next the two gender groups were also subdivided in another way as

- Private School boys
- Government School boys
- Private School girls
- Government School girls

ANOVA was performed to find the difference in the means of the subdivisions listed above. Variation of combined weighted scores (Mean+SD, count) (Mathematical achievement, concept and ability) of students of various schools of Bongaigaon district were carried out in keeping with the above subgroups. Values having different superscripts (a,b,) differ significantly (P<0.05) between groups/levels in a class

<table>
<thead>
<tr>
<th>class</th>
<th>Private School Boys</th>
<th>Government School Boys</th>
<th>Private School Girls</th>
<th>Government School Girls</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>VII</td>
<td>Mean+SD 41.51 ± 14.46</td>
<td>25.78 ± 12.17</td>
<td>39.91 ± 12.52</td>
<td>24.67 ± 10.90</td>
<td>26.853 **</td>
</tr>
<tr>
<td></td>
<td>N 30</td>
<td>125</td>
<td>32</td>
<td>103</td>
<td></td>
</tr>
<tr>
<td>IX</td>
<td>Mean+SD 49.67 ± 13.05</td>
<td>26.96 ± 14.17</td>
<td>46.76 ± 15.48</td>
<td>25.26 ± 12.55</td>
<td>42.005 **</td>
</tr>
<tr>
<td></td>
<td>N 32</td>
<td>131</td>
<td>28</td>
<td>99</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 7.3 Mean scores of students divided on basis of gender-school management

Figure 7.3 Mean scores by gender-school management group
The opinion of the students regarding taking up mathematics as a subject in their future studies was also sought. The figures reveal that in case of boys 45% (class IX), 42% (class VII) wish to take up mathematics as a subject in their future studies. In the case of girls 30% (class IX), 21% (class VII) show an inclination to study mathematics in future. On the other hand 26% (class IX), 30% (class VII) of boys are disinclined to take up mathematics in future while 37% (class IX), 42% (class VII) of girls do not wish to study mathematics in future. The rest of the students in the sample remained undecided.

Figure 7.4 Response of students to future study of mathematics
The above figures suggest that though there are no significant differences in the mean scores of boys and girls, there exist differences in their participation in mathematics-related careers.

Questions relating to confidence in studying mathematics were also put to the students during field study. They have been reproduced below.

<table>
<thead>
<tr>
<th>Statements</th>
<th>VII</th>
<th>IX</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agree</td>
<td>Indecisive</td>
</tr>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>1 I am good in mathematics</td>
<td>58.6</td>
<td>55.7</td>
</tr>
<tr>
<td>2 My parents think I am good in mathematics</td>
<td>62.3</td>
<td>49.4</td>
</tr>
<tr>
<td>3 I answer questions in the mathematics class</td>
<td>59.2</td>
<td>53.8</td>
</tr>
<tr>
<td>4 I am anxious before a mathematics examination</td>
<td>23.7</td>
<td>59.4</td>
</tr>
<tr>
<td>5 I can do better in mathematics if I put in more effort</td>
<td>73.6</td>
<td>70.4</td>
</tr>
</tbody>
</table>

TABLE 7.4 Response (percentage) to questions relating to confidence in studying mathematics

Stacked columns showing the percentage of each response to different statements have been shown below
Figure 7.5 Percentage of different responses across total students to statement 1

Figure 7.6 Percentage of different responses across total students to statement 2
Figure 7.7 Percentage of different responses across total students to statement 3

Figure 7.8 Percentage of different responses across total students to statement 4
Thus among the study sample it is seen that the boys are more self-confident regarding their capacity in learning mathematics regardless of actual performance.

Finally, as a part of this study the opinion of the students was sought regarding the existing of gender bias on part of the teacher favouring boys in the classroom. It is worth noting that from among the girl students 67.3% reported no such bias, 24.4% were uncommitted while only 9.3% felt that the teacher was partial to the boys with regard to mathematics education.

7.4 DISCUSSION

The findings of the above study indicate that though there have been many research studies showing the existence of gender disparities in mathematics education,
it is also a fact that these gender gaps are being diminished over time. This is in keeping with the results of recent research studies conducted in this area.

In a current meta-analysis of world wide data it was found that stereotypes about female inferiority in mathematics are a distinct contrast to the actual scientific data. The results show that girls will perform at the same level as the boys when they are given the right educational tools and have visible female role models excelling in mathematics. (Else –Quest N et al, 2010). Findings by Lloyd J, Walsh J and M S Yailagh (2005) indicate girls’ mathematics achievement exceeded that of boys and their attribution patterns were more enhancing than those found in earlier studies. It was further found that the confidence level of girls in doing mathematics relative to their actual achievement was lower than that of the boys. According to (Cohen & Kosler, 1991; Hanson, 1992) female students report less confidence in their mathematical abilities than their male counterparts. Replicable achievement differences in mathematics were observed across grade levels for student SES and race, but not for gender by researchers (Kohr et al 1989 ). In a study conducted by Dutta(2002) in six districts of Assam it was seen the achievement difference between gender for both class I and class III and for both Language and Mathematics stands at statistically insignificant level. Other studies also show the diminishing gender gap in mathematics achievement. (Kelly A 1987,Gutbezahl, J. 1995).

There was only a only a negligible difference in the mean scores of boys and girls of both class IX and class VII. The independent sample t-test showed that these differences are not significant. Subsequent ANOVA conducted on the subgroups revealed average of the combined scores was not the same for all groups .There is seen that there are significant differences in the means of the combined scores for different
areas, favouring urban areas. However within a particular area (rural, urban) no significant difference in the means of the combined scores of boys and girls were seen.

The school area was related to student performance in mathematics. An urban rural divide existed. The case for boys and girls performing alike within urban areas may be credited to small families and educational aspirations of parents being the same for their children whatever be their gender. Both boys and girls receive the same encouragement and support within the family, and are provided with extra coaching in the form of private tuitions. The influences of peer group of high achieving students and awareness of the role of mathematics in diverse career options also play a part.

Inside the rural areas this can be explained by the policies taken by the government to improve girls’ education. The government’s programmes include removing the financial barrier to girls schooling directly by eliminating fees for girls and indirectly reducing costs to households by the mid-day meal scheme. With the removal of household education expenditure there is an encouraging change in the attitudes of the family to promote education for girls. Another factor maybe the minimum qualification required for jobs in rural areas. As mathematics is a compulsory subject at school levels girls are thus encouraged to study it and pass in it just like any other subject. All of this may explain the shift in the traditional view and practices of rural families considered detrimental to girls’ education,

Similarly ANOVA carried out on subgroups segregated according to school management showed significant differences in the means of the students which are in favour of private schools. This suggests that the quality of education received plays an important part in the mathematics education of the student. On the other hand within the same school management (government, private) no significant differences occurred in the mean scores of boys and girls.
Additionally from the above data it is seen despite there being no significant difference in the mean scores of the students, more boys than girls are predisposed to taking up mathematics as a subject in their future studies leading to careers in related fields. Preference for taking up mathematics related careers was also reported by researchers like (Fierros E G 1999, Kolhe S.P.1985) Many girls capable of learning the mathematics required in higher classes choose not to learn mathematics when they have the choice at a higher level. This may be because of unbiased personal choice in some cases but also the social environment, economic status and self confidence in learning higher level mathematics may play a part. The figures from table

The above analysis would suggest that gender differences if any which exist should be considered in the social, economic and cultural context. These factors do influence mathematics education as has been seen in the earlier chapters. The impacts of these socio-cultural factors on the biological characteristics have to be taken into account on any future research studies dealing with gender and mathematics.

For the development of the country it is necessary that each member of society respects others and plays a role in which they can fulfill their potential. Gender issues in education being a part of the broader goal of gender equality should thus be addressed appropriately. Considering the importance of mathematics education as an important tool in nation building, emphasis should be given to building up awareness of this subject to all students because mathematical knowledge provides power in understanding other areas of knowledge as well provides the possibility of choice. Equal opportunities to pursue this subject should be given to both boys and girls.

Discussion of this chapter is based on our paper entitled “The Effect of Gender on Mathematics Achievement Among School Students” which is published in the Bulletin of the Gauhati University Mathematics Association, Volume 11 (2010), pp-121-136.