

EXPLORATION OF MATHEMATICS LEARNING OF SCHOOL GIRLS IN DELHI

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Despite being good at Mathematics right from the beginning the Researcher has often come across the prejudice that 'girls are not good at Mathematics'. After so much efforts put in by the government the same old mindsets still exists even in this era of 21st century. This disparity propagates not only among common men but also among teachers, parents and students themselves. So this action research is a small way of finding something related to Mathematics learning affected by gender perceptions. The paper summarizes a large number of lived experiences that the Researcher has gone through in her life as she is not only a researcher but a practitioner (senior secondary school teacher) as well. This study was undertaken to explore gender perception in Maths learning. The study sensed many dimensions of the relationships between gender and Mathematical learning viz. girls self concept, their socialization, Maths pedagogical issues, thinking pattern, role of teachers etc through semi structured interviews with Kendriya Vidyalaya students, parents and teachers. Comparisons were made in the performance of students in CBSE conducted board examination and sample examination paper prepared by the practitioner. Further, a deeper comparison of girls performance in regular examinations and in Maths Olympiad was done to arrive at conclusions.

INTRODUCTION

Prejudice of girls having taken the rear seat in Mathematics appears a reality. The belief has found many takers in the society as they encourage a girl-child to ignore Mathematics after her class XII and in some cases even after class X. It is further supported by the fact that fewer girls opt for Mathematics as an optional paper in Civil Services Main Examination. The data from UPSC Civil Service Examination 2014 shows that boys to girls ratio who opted for Mathematics as the optional subject stood at 19:1 against the overall boys to girls' ratio of 3.39:1.

Being a student and teacher of mathematics, the researcher has been facing this 'problem' continuously, proving herself time and again by fighting against the mind-set "Girls can't do better in mathematics". This mindset in turn seems to influence the performance and hence, identity of girls. When it is discussed with colleagues and other elementary school teachers, then an important fact emerged that girls perform at par if not better than boys in school/academic Mathematics (i.e. in text book Mathematical problems).

The following are some perceptions that emerged from the discussions of school teachers:

- "Whenever we ask questions beyond prescribed syllabus or questions related to Intelligent Quotient (IQ) testing, then Boys start outscoring girls."
- "Boys perform better in Mathematics as they have higher I.Q"
- "Arts subjects are girlish, Maths is masculine subject."

- *“Girls are meant primarily for Biology, only the right side brain of girls is developed.”*

These days the notion of I.Q. is debated. Even if we talk about the intelligent quotient, it is independent of gender or sex then how does such a prejudice come into existence? Mathematics is the subject of logic and rationality by which mind can be channelized systematically. If it is so then does it mean that girls do not have ‘power of conscience’? Certainly, the perception of society towards girls’ ability to perform in Mathematics is questionable. ‘Gender’, is not related to biology, it is rather effect of socialization. In Indian context, household discussions may easily lead us to believe girls are trained to think differently than the boys. The famous educationist and psychologist Skinner (1938) has proved that our mind can be conditioned in a pre-determined way. Primary as well as secondary socialization helps in achieving this. While on one hand, Primary socialization has deformed their self-concept gradually; on other hand secondary socialization has created an environment which is different to the boys’ environment. For instance girls are given dolls as their playing toy but boys are given ‘cars/guns’. Clearly, boys are exposed to engineering skills more in their childhood itself. Mathematics can channelize our mind scientifically and logically. This research paper is an attempt to explore this silent conspiracy against the feminine gender. The Researcher is in search of a solution to the problem outlined above by being in resonance with the underlying concept.

CONTEXT OF THE RESEARCH

The researcher collected data from one of the Kendriya Vidyalayas following CBSE syllabus. The school is run by an autonomous organization – KV Sangathan established 1959 under Ministry of Human Resource Development. It is one of the 1498 schools in India run by it. KV schools are famous for the infrastructure and the excellent results that are produced by their students. The chosen school has about 1500 students with almost equal number of girls and boys.

OBJECTIVES OF THE STUDY

1. To explore the mathematics learning of girls at secondary and senior secondary level of schooling. To find if there are differences between the genders in terms of their conceptual understanding of the subject matter that impacts performance.
2. To find out the reason behind obstacles to mathematical learning if any, that girls face while solving a mathematics problem. To see if there are factors in social environment that deter girls performance in Mathematics ?

REVIEW OF RELATED LITERATURE

The research questions lie in the area of ‘Gender and Mathematical learning’. “Gender is not a women’s issue but people’s issue, as gender is a social construct not biological. It means that gender relations are neither ‘natural’ nor given, they are constructed to make unequal relations seem ‘natural’ and can be naturalized only under the dresses of socialization.” (Fennema, 2000).

Mathematics is a discipline by which we can strengthen ourselves not only being efficient in numeracy but through logical and rational thinking as mentioned in National Curriculum Framework, (2005). The document also mentions that the output of Mathematical learning is the Mathematization of thinking that encourages students to think in a different manner. A

student cannot measure the width of a road but (s)he can judge the same just by lying on the road multiple times and equating with his own height/length.

The NCF, 2005 focuses on “Mathematics is for all and everybody can learn Mathematics”. These “mathematical abilities are not innate but are properties acquired in life that are formed on the basis of certain inclinations..... anyone can become an ordinary mathematician” (Orton, 2004, p. 361).

Elizabeth Fennema (2000) in her longitudinal research for thirty years on toppers in achievement cum diagnostic test in mathematics in the age group of 4-12 years found that there are a number of complexities regarding mathematics learning. The complexities are not only related to conceptual understanding but also to variables like mental ability, social barriers, teacher’s perception, classroom environment, self-concept and many more. But apart from this, a devastating reality exists that is there is gender gap in Mathematics learning. This gap has been shown by several researches and the data from sources like International Mathematics Olympiad which has been conducting test for extremely talented young students since 1959 over 100 countries. The data from this international evidence clearly shows that only 5.7% (185 of 3246) are female. The rate of qualified female has increased over the years but at a very slow pace (IMO Website) i.e.

1988-1997	7.5%
1998-2008	9.7%
1999-2014	10.8%

In another research in Indian context, Vibha Parthasarathy (1988) remarked that “Girls are poor in Mathematics; Mathematics are for boys; such gender stereotypes are so deeply imbibed that now we felt originally” She highlighted that if a thing is repeatedly done for years, then it appears as a truth and becomes a part of process of socialization. She reiterated the fact that gender stereotypes begin to form at a very early age and social norms set by patriarchal members, acceding women and media are so deeply absorbed by child that they accept them wholly.

If we go into the depth of such ‘Mindsets’, we’ll get certain facts that a girl may feel a conflict between wanting to be seen as a female and doing well at mathematics and mathematics is generally not associated with being feminine (Nosek, Mahzarin & Greenwald, 2002). Even though young boys and girls have generally equal Mathematics ability as they get older, girls do not do as well as boys because they convince themselves that they are not good at Mathematics and being good at Mathematics is more “appropriate” for boys than them leading girls to doubt their ability, consequently, affects their decisions for future enrollment in Mathematics Class (Frenzel, Pekrun & Goetz, 2007).

In another research on the Coloumbia university girl student, the researchers during their calculus course observations found that ‘Self-concept’ is formed by believing that mathematics is a sort of gift by God. But the danger behind such belief isolates people from the subject’s belongingness. Thus, researchers concluded that there is no difference in ability but difference in how students cope with experience that may call their ability into question” (Dweck, 2006).

Benbow and Stanley (1980) and Hill et al., (2010) found that there are several obstacles to mathematical learning for example: social barriers, stereotypes, gender bias and discouraging classroom atmosphere can deter women from pursuing careers in the areas and may explain why there are so few female scientists and engineers. These are controllable and more related

to social pressures rather than actual ability and academic performance. However, in Indian context, several socio-cultural conditions like negative attitude of parents, early marriage, after marriage –attitude of husband and in-laws, future perspective, non-working women, and unequal opportunities of boys and girls many more are reflected by Giri’s paper (2004).

A survey (2013) was done over 14000 engineers and graduates shows that a girl to boys ratio is as follows:

Applicant	1:2.27(IIT)
	15:100(MIT)
Selection Rate	1.9:100(IIT)

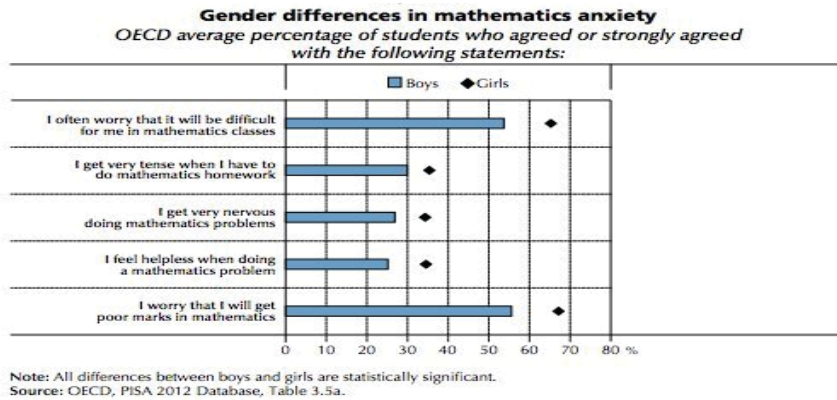


Figure 1: Graph showing gender difference in mathematical fear factor

It is inferred from the data that fewer numbers of girls are applying and even less is qualifying. These again bring back to ponder about issues like: Are there equal opportunities for boys and girls? What percentage of applicants are girls in any competitive examination based on mathematical skills? Whether the paper relates to their own environments ? Is classroom environment conducive to girls?

The review of research in the area of gender and mathematics learning indicated that there are a lot of obstacles to girls’ performance in mathematics. With this background the researcher has tried to find answers for research questions.

RESEARCH SAMPLES

A sample set of students, teachers and parents were chosen as follows

Students

Students were chosen from Class XI, with 40 boys and 21 girls. Interestingly, despite the school strength equally distributed among boys and girls, the researcher could find only half the number of girls opting for mathematics in XIth class than boys. This in many senses reinforce the underlying mindset / perception this research is aiming to explore. Students are generally wards of Central Government Employees with transferrable jobs, belonging to lower middle class family, and living within a radius 2-2.5 km from School. The school charges a moderate fee of INR 800 per month with further exemptions for economically and socially disadvantaged students.

In addition, 5 boys and 5 girls of class Xth were also interviewed.

Teachers

2 Male Teachers and 4 Female Teachers, which makes a total of 6 teachers, were selected as a sample. Again, it is interesting to note that generally mathematics teacher would be a female. In other words, finding female Math teacher is a lot easier. Of the six teachers interviewed, 3 belong to Kendriya Vidyalayas from different branches (one each from INA Colony, Janakpuri, and Sector-2 R K Puram). The other three teachers are from a Private school, State government school in Delhi-NCR and third one from Sarvodaya Vidyalaya School run by Delhi Government. The selection of these teachers was made so that teachers from different parts of the city and teaching in different types of schools were chosen. All the teachers chosen in sample have experience of more than five years.

Parents

A total of 6 No of parents were chosen of which Three included those whose wards are in the research sample. The other two are from private school of Delhi-NCR and one from a state school run by Delhi Government. Data is collected from IIT-Kanpur and Guwahati also for comparing the boys to girls' ratio in these premier institutions. Further, Data is collected with respect to ratio of girls qualified in KVS Junior Mathematical Olympiads for last two years organized by KVS Junior Mathematics Olympiads every year. Both quantitative and qualitative data were collected and analyzed to get a comprehensive picture for answering research questions.

TOOLS FOR RESEARCH

The following tools were developed by the researcher:

Semi-structured Interview Schedule: It is an open ended interview schedule which is separately prepared for unstructured conversation with parents, teachers and students. Some exemplars from these interviews are: *“When you go shopping, who calculates faster at the shop—your son or daughter of similar age?”* or *“ Do you think, you need to study Maths for your dream career? If yes, would you still opt for that or would you like to change your option?”*

Achievement test paper for Mathematics: One previous year Central Board of Secondary Education (CBSE) mathematics paper was chosen and other was prepared by researcher. These two tests varied in terms of nature of questions. CBSE papers primarily contain text book questions with little change in data values and are repetitive with respect to previous years. They will seldom go to check the deep understanding of the subject matter. The achievement test paper contained thought provoking questions as confirmed by five different experts in the field of mathematics as well as the students who took the test. These items are more of practical in nature and led to “Mathematization of Thinking”. Some of the questions asked in the paper are given below:

- 1. In a cricket match consisting of 22 players, the probability that at least two of them share a common birthday lies between 0.45 and 0.5. Am I serious or joking? (4 Points)*
- 2. From a point inside an equilateral triangle 3 perpendiculars are drawn to the sides of the triangle of lengths 3,4,5 cms. Find the area of the triangle. (4 Points)*
- 3. Gold is known to weigh 19 times the weight of water and another metal M is known to be 9 times the weight of water. In what ratio should these be mixed to result in an alloy that is 15 times the weight of water? (4 Points)*

Comparative study of results of Olympiad, IIT JEE with academic performance.

PROCEDURE

Both achievement tests for mathematics were conducted in class room setting. Semi structured interview were conducted with teachers, students and parents to know their perception about learner's identity and mathematical learning.

DATA ANALYSIS: ESTABLISHING DIALOGUES WITH DATA

Teachers' View: Out of six teachers interviewed four believed that there is a difference in mathematical ability between boys and girls. One of them said that this difference in ability is seen after third class. Almost all teachers said that boys outperform in mathematical reasoning / logic, calculations and specially visualizing spatial problems. Teachers mentioned that boys do not take interest in any type of projects / assignments but they question over questions and show excitement towards new questions/problems. Two teachers even generalized that projects made by girls are related to kitchen, fashion, households etc. One of the teachers put the onus on the process of socialization mentioning that girls have lesser exposure to real outside world problems like grocery shopping, travelling alone, filling gas cylinders or paying electricity bills. Boys are frequently exposed to the outer world helping them make sense of directions, calculations, spatial things etc.

One teacher emphasized that there is no difference in performance of mathematics among boys and girls but the way they learn is definitely different. Like "13 year old boys are likely to be more interested in the context or how the concept originated than the same age group girls who tend to focus on real world applications of number theory than in remote abstractions To elaborate- if we want to discuss quadratic equation with boys then I must tell what necessities of that concept are.... and I have to start like:

The general form of such equation is $ax^2+bx+c=0$; Procedure of Finding its roots and its applications. But, If I project this concept to girls then I will start like: Think about a rectangular garden in which length is two units more than its breadth and its area should be 24 units. They frame this as $x(x+2)=24$ which implies $x^2+2x-24=0$;

Then boys will not only be excited but also oriented towards quadratic equations".

One teacher mentioned that he found differences in mathematics performance of urban and rural areas but no difference was found among rural girls and urban girls in mathematical ability.

Parents' View: One parent believed that girls have more analyzing capacity which is used in social sciences, literature etc. But in logical thinking and number ability boys are outperformers. Other parent, who is also a teacher linked it with notoriety ('KHURAPHAT') and exemplified through her son/daughter's actual behaviour in tackling mathematical concepts. She clearly explained - how her son tries to understand the concept but daughter tries to memorise the procedure of solving mathematical problem. Most of the parents tried to connect this ability through our social bringing up which for girls is different. Girls are imposed with several obstacles and hindrances of society. One parent explained as "20% of girls are genius and they do not get affected by any kind of hindrances, 50% of them are normal and they are deprived of several opportunities and exposures, and the remaining 30% of them lag by making such 'self-concept". One teacher and parent as well, referred to a news article (published on 8 March 2014 in Times of India) mentioning that "*even C.V.Raman, the great scientist had opposed the progress of a lady scientist in his time. In such scenarios*

confidence level of girls lower gradually". Two parents mentioned that their daughter is better than their son in maths; But instead of saying that their girls are brighter than boys they attributed success to hard work.

Almost all parents accepted the existence of a type of 'Fear' factor behind learning mathematics or opting mathematics as a career. Parents primarily stressed upon 'fear' which is associated with pass percentage or future career. It is evident from the fact that number of students in commerce without mathematics is more than number of students with mathematics. Teachers also emphasized on fear which is related to confidence level (risk factor) like the type of questions given in exams.

Students' View: During the discussion with students, they revealed that they do have a 'fear' for performance in mathematics which is much higher than compared to other school subjects. Girls stated that they prefer to attempt questions which they had earlier practiced. They "will not take risk in examinations". Girls were more worried about their failure in terms of disappointing their adults but for boys it is a matter of lack of interest or knowledge in a specific area. Girls look up to teachers for motivation and emotional support but for boys teachers are facilitator.

PERFORMANCE IN ACHIEVEMENT TEST

It was found that girls attempted more items based on formula whereas boys attempted tricky items. Boys primarily populated the highest range position. Boys also found a lot of entries in the lowest marks range. However, the middle ranges were interspersed with boys and girls which is represented by a graph in Figure 2. While discussing their performance boys blamed lack of revision of concepts whereas girls blamed lack of awareness of pattern.

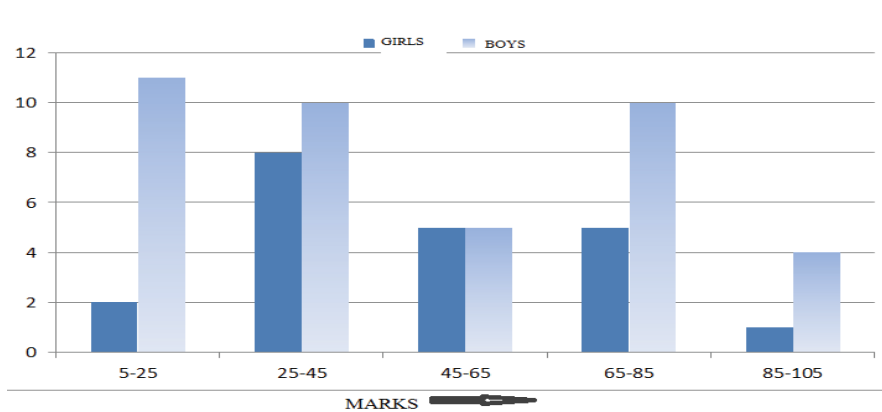


Figure 2: Comparative performance of boys and girls in achievement test paper

CONCLUSION

The above analysis leads to conclusion that there is indeed a striking difference between girls and boys performance in examinations. This also unveils some interesting facts like – Girls do manage to perform occasionally well-even sometimes getting the top rank. However, their position in the ranking charts are often ephemeral. While solving a problem it was evident that there is an inter linkage between gender and mathematics. At the same time, it could not be established that how learning a particular subject can depend so heavily on class of students learning the subject. Also, it does not matter what boys or girls can learn but big

difference lies in the method adopted to make them learn. A lot of debate can be held on this, however, it can be easily concluded that *perspective* with which a student tackles a subject is gender dependent. Specially when this perspective is enhanced through family, schools and society, with time this perspective gets internalized as a **“Self- Concept”**. Thus, **girls’ environment and their bringing up** have been trying to keep them far away from this subject. Reasons for this are many: mathematics treated as ‘Masculine subject’ not meant for girls, fear of failing in mathematics, anxiety about performance and many others. Secondly, **evaluation system, thinking pattern, pedagogical issues and role of teachers** should also be redefined or re-evaluated critically as performance was changed with the change in achievement test.

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