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Study On Cognitive Development Regarding the Acquisition of Basic Geometric Concepts Among Middle School Children with Special Reference to Gender Differences.

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Abstract:

Maths and Geometry are both liked and feared by generations of students. Math is generally seen as a male domain, much research has gone into finding out the truths whether boys are really better at maths, than girls. While some findings show gender equity others reinforce male superiority in mathematics. In our culture gender divide is often very apparent. This probably affects spatial skills differently of boys and girls as also their competence in geometry. This study has also attempted to find out whether there is indeed any gender disparity in learning geometry and whether this is affected by class (VII and IX), locality (urban/ rural) and by parents' profession. The sample consisted of 1030 boys and girls in class VII and IX in Kolkata and surrounding districts. The tools consisted of a personal data sheet and a scale entitled "How Much Geometry Do You Really Know ?" constructed by the investigator. Quantitative techniques of data analysis revealed that boys scored higher than girls in geometry achievement. This was consistently apparent in nearly all subgroups of the sample.

Key words.: *Visual -Spatial skills, Basic Geometric Ideas, Location and Parents' Professions.*

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I. INTRODUCTION & PROBLEM

Geometry is a part of mathematics that evokes a variety of sentiments. Some enjoy solving geometric problems and relish in connecting geometry to their surroundings, others bulk at the mention of geometry and find its logical exposition beyond their cognition. Geometry being an essential area of mathematics is a must to do for children in secondary schools. Passing the school examination therefore means that students have a modicum of proficiency in geometry. Yet experience shows that many adults cannot cope with the geometry related demands of life. Some adopt avoidance techniques to circumvent those problems, while others suffer helplessness. A common example is that of the inability by all and sundry to follow the GPS system of navigation.

The above reflections bring to mind that there must be some lacunae in the dissemination and cognition of geometric concepts. This idea is further reinforced when one looks at adults who proficiently carry out primitive tasks (like the fruit seller arranging his wares) without being conscious of its geometric significance. Children also indulge in different games that unconsciously borrow from their innate visual spatial capacity. Unfortunately, the formal and the informal manifestations of geometry have failed to coincide among the protagonists in the above illustrations. Exactly where and how these gaps occur may be worth finding out so that a cognizant and attractive picture of geometry may emerge before the public.

Tuncay Saritas and OmurAkdemir (2009) suggested that the quality of teaching and learning mathematics has been one of the major challenges and concerns of educators. Instructional design is an effective way to alleviate problems related to the quality of teaching and learning mathematics. Knowing the factors affecting math achievement is particularly important for making the best design decisions. Therefore they conducted a study to identify the factors affecting the math achievement of students through collecting the opinions of math department students. Results revealed that instructional strategy and methods, teacher competency in math education, motivation or concentration and also various demographic factors such as gender, socio-economic status, and parents' educational level which have been analyzed in their study as predictors of math achievement, were the most influential factors that should be considered in the design decisions.

A number of studies focused on gender differences from the point of view of geometry achievement. They presented conflicting findings regarding the superiority of boys or girls in geometry. For example, Hanna (1986), and Fennema (1981) reported that boys had higher scores than girls in geometry and measurement. On the other hand, Senk and Usiskin (1983) noticed no significant difference between geometry scores of boys and girls. Issacson (1989) proposed that mathematics has been seen to be 'hard subject', not necessarily in the sense of intellectually difficult, but hard, as opposed to soft, as masculin to feminine. This leads to another widespread mathematical myth that 'mathematics is a male dominant subject.' Moreover, mathematics as a field of study is often linked to masculine jobs such as military and engineering. Thus many people including primary and secondary students, adults, parents and even teachers regard mathematics as a male domain (Shuard, 1982). There is also a widespread belief that boys are better in mathematics than girls (Burton, 1989). Thus the effect of gender difference in acquisition of any mathematics skill cannot be ignored.

The Second International Mathematics Study (SIMS, 1982-1983) shows that gender differences do not appear in mathematical learning except in the least taught areas, such as geometry and measurement. In these areas, prior out-of-class experience is significant. In many societies, girls often do not

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play games that enhance their visual spatial knowledge. According to Gaulin (1985), girls are therefore disadvantaged when these topics are taught in class. However, using concrete materials in the mathematics class would provide opportunities for all children to develop their skills in measurement and geometry. The NCTM (1989, p. 70) draws the attention of educators to reasoning in spatial contexts and deductive reasoning. The activities involving concrete models would give students an opportunity to engage in learning, both mentally and physically, by practicing spatial reasoning through visualization.

Many scholars who studied achievement differences between boys and girls found little variation in mathematics achievement during the elementary school years (Fennema, 1974; Hyde, Fennema, and Lamon, 1990). However, significant gender differences appear as students advance to the middle school. Boys outperform girls in some mathematical skills and girls outperform boys in the others (Campbell and Beaudry, 1998; Brandon, Newton, and Hammond, 1987; Fennemaand Carpenter, 1981).

A study through a meta-analysis by Hyde et.al reveals that males tend to do better on mathematics tests that involve problem-solving (Hyde, Fennema, and Lamon 1990). Females tend to do better in computation, and there is no significant gender difference in understanding math concepts. Another study shows that females tend to earn better grades than males in mathematics (Kimball, 1989).

Some recent studies have revealed that gender differences in mathematics education seem to be narrowing in many countries. However, studies indicate that as students reach higher grades, gender differences favor increase in math achievement by males (Campbell, 1995; Gray, 1996; Mullis, Martin, Fierros, Goldberg, & Stemler, 2000). For instance, the results from the Third International Mathematics and Science Study showed that mathematics achievement scores of each gender group were close to each other at the primary and middle school years (Beaton et al., 1996; Mullis et al., 1997). However, in the final year of secondary school, evidence was found for gender differences in mathematics achievement. Another study, which was conducted to analyze factors that affect math achievement of 11th-graders in math classes with an identified gender gap, also showed that males scored higher than females on 11th grade math achievement test, but this difference decreased from 10th grade (Campbell & Beaudry, 1998).

In addition, gender differences in attitudes and perceptions of the usefulness of mathematics for middle school students were found statistically important (Lockheed, Thorpe, Brooks-Gunn, Casserly, and McAloon 1985; Oakes 1990). For example, female students show less interest in mathematics and have negative attitude toward mathematics. It is also reported that girls tend to learn mathematical concepts by means of rules or cooperative activities, while boys have a tendency to be in a competition to master mathematical concepts (Fennema& Peterson, 1985; Hopkins, McGillicuddy-De Lisi, & De Lisi, 1997).

Some aspects of mathematics are believed to have a spatial component (e.g., as reviewed by Fias & Fischer, 2005), and correlations between math and visual spatial skills have been reported in early grades (Kulp, 1999; Kurdek & Sinclair, 2001; Mazzocco & Myers, 2003). The shift toward male superiority in math, in higher grades, has been attributed in part to an increasing reliance on spatially based strategies, which boys are alleged to use more often (Benbow, 1988; Casey et al., 2001; Maccoby & Jacklin, 1974). This notion is somewhat controversial, as it has not been supported in all studies, such as in Manger and Eikeland's (1998) study of sixth graders' mathematics and spatial visualization skills.

Comparable to findings on math skills, studies on sex differences for spatial abilities across the lifespan have yielded inconsistent findings. Levine, Huttenlocher, Taylor, and Langrock (1999) report a difference in favor of boys, at 4 years of age, on both rotation and translation skills. Kaplan and Weisberg (1987) found that third-grade girls performed significantly better than boys on tasks involving recognition of embedded figures. Vasta, Regan, and Kerley (1980) found no significant sex differences among 10-year olds on fine motor and gross motor skills, consistent with Manger and Eikeland's (1998) report of no sex differences among sixth graders on spatial visualization tasks. As noted by Voyer, Voyer, and Bryden (1995), sex differences on spatial tasks do not appear at one age, rather, they emerge on different tasks at different preadolescent and adolescent ages, and their magnitude increases with age. In contrast to this notion, Johnson and Meade (1987) report a consistent male advantage on spatial performance starting at age 10 years and continuing through age 18. In adulthood, studies typically report more consistent findings of a male advantage on spatial cognition and ability measures (Geary, Saults, Liu, & Hoard, 2000), with the largest discrepancy in favor of men on mental rotation skills (Crucian&Berenbaum, 1998; Geary, Gilger, & Elliott-Miller, 1990; Voyer et al., 1995). Indeed, some argue that the spatial superiority reported for males is limited to very specific tasks, such as mental rotation tasks and location learning in young adults (Astur, Oritz, & Sutherland, 1998). This means that sex differences may not be apparent on global tests of general spatial abilities, as Alyman and Peters (1993) have reported in their cross sectional study of spatial abilities using everyday prompts, from childhood to adulthood.

According to Colleen M. Ganleyand MarinaVasilyeva, sex differences have been previously found in cognitive and affective predictors of mathematics achievement, including spatial skills and mathematics attitudes. It is important to determine whether there are sex differences not only in the predictors themselves, but also in the nature of their relation to mathematics achievement. They examined spatial skills and mathematics attitudes as predictors of curriculum-based measures of mathematics performance in middle-school students, specifically comparing the patterns of these predictive relations for boys and girls. The results of their study showed that, despite similar levels of mathematics performance for boys and girls, the significance of particular predictors varied as a function of sex. Specifically, spatial skills predicted mathematics performance in boys, but not in girls. They suggested that sex differences in spatial reasoning in conjunction with the differential involvement of spatial reasoning in mathematics problem solving may lead to later sex differences in math outcomes.

Jennifer A. Lachance and Michele M.M. Mazzocco(2010) reported on a longitudinal study designed to assess possible sex differences in mathematics achievement, mathematics ability, and mathematics-related tasks during the primary school age years. Participants included over 200 children from one public school district. Annual assessments included measures of mathematics ability, mathematics calculation achievement scores, rapid naming and decoding tasks, visual perception tests, visual motor tasks, and reading skills. During the selected years of the study they also administered tests of counting and mathematics facts skills. They examined whether girls or boys were overrepresented among the bottom or top performers on any of these tasks, relative to their peers, and whether growth rates or predictors of mathematics-related skills differed for boys and girls. Their findings supported the notion that sex differences in mathematics are minimal or nonexistent on standardized psychometric tests routinely given in assessments of primary school age children. There was no persistent finding suggesting a male or female advantage in mathematics performance overall, during any single year of the study, or in any one area of mathematics or spatial skills. Growth rates for all skills, and early correlates of later mathematics performance, were comparable for boys and girls. The findings fail to support either persistent or emerging sex differences on non-specialized math ability measures during the primary school age years.

Capraro (2001)examined the difference between student performance on two separate measures, the spatial visualization portion of the "Differential Aptitude Test" and "Geometry Content Knowledge Test". Results from the hybrid quantitative/ qualitative study indicate although there were no differences in performance on spatial visualization for males and females or across ethnicities, difference in performance on geometry content knowledge tasks for ethnicity were evident.

Moreover, in a study conducted by Kawakami, Steele, Cifa, Phills, and Dovidio (2008) they examined attitudes towards math and behaviour during math examinations. The study examined the effect of extensive training in teaching women to approach math. The results showed that women that were trained to approach rather than avoid math showed a positive implicit attitude towards math. These findings were only consistent with women low in initial identification with math. This study was replicated with women who were either encouraged to approach math or received neutral training. Results were consistent and demonstrated that women taught to approach math had an implicit positive attitude and completed more math problems than women taught in a neutral manner.

Johns, Schmader, and Martens (2005) conducted a study in which they examined the effect of teaching stereotype threat as a means of improving women's math performance. The researchers concluded from the study's results that women tended to perform worse than men when problems were described as math equations. However, women did not differ from men in a condition with a test sequence described as problem solving or in a condition in which they learned about stereotype threats. This research has practical implications; educating female teachers about stereotype threat can reduce its negative effects in the classroom.

There has been research examining gender difference in performance on standardized tests across various countries. Beller and Gafni's have shown that children at approximately nine years of age do not show consistent gender difference in relation to math skills. However, in 17 out of the 20 countries examined in this study, 13 year old boys tended to score higher than girls. Moreover, mathematics is often labeled as a masculine ability; as a result, girls often have low confidence in their math capabilities. These gender stereotypes can reinforce low confidence in girls and can cause math anxiety as research has shown that performance on standardized math tests is affected by one's confidence (Dar-Nimrod & Heine, 2006). As a result, educators have been trying to abolish this stereotype by fostering confidence in math in all students in order to avoid math anxiety.[Kail, R.V., &Zolner, T. (2005). Children.Toronto: Prentice Hall.

Related to this discussion are the beliefs that as younger female scholars develop anxiety towards mathematics and sciences when they become more interested in social relations in their teen years. It is thought that women experience more anxiety in mathematics as a group than men and this has also been suggested in regard to computer programming. (Copper, Joel, & Weaver D, Kimberlee. *Gender and Computers: Understanding the Digital Divide,* Mahwah, N.J.: LawrenceErbaum, 2003).

It has also been suggested that in primary elementary years, if female students have an anxious female math teacher, they are more likely to confirm the math anxiety as a gender stereotype. Girls are more likely than boys to take notice of their female teachers "negatives and fears about math", which could negatively influence their future pursuit of the subject. Bielock, Sian, Elizabeth Gunderson, Gerardo Ramirez, and Susan Levine. "Female teachers' math anxiety affects girls' math achievement." PNAS 107, no. 5 (2010): 1860-1863.

One method to help address this issue is ensuring that teaching programs reinforce positive attitudes towards math, and helping teacher trainees solidify their grasp on mathematics."Female teachers' math anxiety affects girls' math achievement." (Bielock, Sian, Elizabeth Gunderson, Gerardo Ramirez, and Susan Levine. PNAS 107, no. 5 (2010): 1860-1863).

The literature on gender differences provides evidences that gender issues impact achievement in mathematics. Hence, it is crucial for educators and researchers to pay attention to gender differences in the design of mathematics instruction.

The effect of gender difference in acquisition of any mathematics skill cannot be ignored. Therefore the objective of this study was to examine the effect of gender difference in acquisition of basic geometric ideas. Children in the middle schoolare on the brink of entering the world of formal geometry. This is also the age where children's gender related characteristics emerge. Thus this study has focussed on the gender differences in the acquisition of geometric ideas by children in the middle schools.

II. METHODOLOGY OF THE STUDY

The Variables of the study are:

- *Independent Variables:* Class, Gender, Location and Parents' Profession parents of students were classified into four groups according to their professions* as follows:

a. P1---parents whose profession involves physical or manual labor (including farmer).

b. P2---parents whose profession involves skills (carpenter, tailor and potter).

c. P3---parents whose profession involves business (shopkeeper and retailers).

d. P4—parents whose profession is teaching/ involves desk work (teachers, clerks, administrative workers).

*Parents' profession gives an indication of the home environment of children.

- *Dependent Variable:* Scores of Geometry.
- *Covariate :* Intelligence Scores.

Procedural Framework

The following steps were taken in conducting the research.

- Population and location of the study was determined from which the prerequisite representative sample was selected.
- Requisite hypotheses of the study were framed against the objectives for systematic investigation.
- Necessary tools of data collection were constructed and administered on the sample, and the results were tabulated.
- Statistical analysis was conducted by using SPSS 16 software and the results were analyzed.
- The findings were then interpreted and supported by various literatures.

Sample

The sample was chosen from a population which consisted of those students who have completed standard VI and entered standard VII (i.e. upper primary school) and those who have completed standard VIII (i.e. elementary school) and entered standard IX(i.e. secondary school), in Kolkata and districts surrounding Kolkata. The secondary schools in Kolkata and surrounding districts were approached and chosen, until the requisite sample size was obtained.

	BOYS	GIRLS	TOTAL
URBAN	278	186	464
RURAL	252	314	566
TOTAL	530	500	1030

The sample was as follows:-

Table of the Sample Distribution

The detailed sample was as follows:-

Sample for Rural Students Table: 1

Class	Rural Boys				Total	Rural Girls				Total
	P1	P2	P3	P4		P1	P2	P3	P4	
VII	56	34	34	17	141	28	56	41	21	146
IX	32	34	43	02	111	48	43	41	36	168
Total	88	68	77	19	252	76	99	82	57	314

The above table shows the number of rural boys and girls students as per Class VII and Class IX according to their different Parents' Professions.

Sample design for Urban Students Table: 2

Class	Urban Boys				Total	Urban Girls				Total
	P1	P2	P3	P4		P1	P2	P3	P4	
VII	03	29	75	62	169	00	15	30	43	88
IX	02	16	31	60	109	00	12	37	49	98
Total	05	45	106	122	278	00	27	67	92	186

above table shows the number of urban boys and girls students as per Class VII and Class IX according to their different Parents' Professions.

III. TOOLS OF THE STUDY

The following tools were used for the investigation:

- Personal data sheet constructed by the investigator to envince the name, age, class, gender, address(forlocation i.e. rural or urban)and parents' profession.
- Catell and Catell Culture Fair (free) Intelligence Scale, Indian adaptation by Kapoor, Rao&Singh(1962),The institute For Personality and ability Testing, P.O. Box 1188, Champaign Illionois 61824,U.S.A published in India by the Psycho Centre, G- 19H- Block Saket New Delhi- 110017.
- Scale for Geometry entitled 'How Much Geometry Do You Really Know? ' constructed by the investigator, for assessing the conceptualisation of basic geometric ideas by the participants. The geometry concepts were identified by consultation with prescribed mathematics text books of the W.B.S.E, C.B.S.E and C.I.S.C.E (formerly I.C.S.E) boards. The content of basic geometric ideas was divided into five main conceptual areas, viz.
- 1 Dimensional figures-------------- Line
- 2 Dimensional figures------------

  a. Plane
  b. Polygon
  c. Types of Polygon
  d. Circle
  e. Triangle
  f. Quadrilateral

- 3 Dimensional figures ------------

  a. Cuboid/Cylinder/Net/Cube
  b. Cone
  c. Sphere

- Angles and directions

Content analysis of each conceptual area was carried out by identifying the properties pertaining to each area. The test was framed by constructing items to evaluate each property. Each item was dichotomous in nature. The scale consisted of 72 items. A total score was assigned to each respondent by adding the individual scores.

The test was then validated by experts in the field, and was administered to a representative sample and the item facility and discrimination index of each item were calculated. The items were of medium difficulty, but discriminated between those tested, ability wise. The inter item correlations were calculated and largely found to be significant. The item total correlations were also found to be significant, thus ensuring the consistency of the test. Finally, the reliability of the test was calculated by Cronbach's (alpha) and found to be .87.

IV. ANALYSIS OF DATA

The personal data sheet, intelligence test and the scale for Geometry entitled 'How Much Geometry Do You Really Know? ' was administered to the sample and the responses were scored and tabulated. The scores were then analyzed according to the concepts within each of the five main conceptual areas through appropriate statistical techniques.

The hypothesis required for the study is as follows:

Ho -There is no significant difference in total scores of geometry between the boys and girls.

This hypothesis was further detailed class-wise, location-wise,and parents' profession wise. The intelligence scores served as the covariate in the exercise. The distribution of total scores of geometry was found to be nearly normal. Thus, ANOVA technique was used to test the hypothesis.

The following table is the outcome of Univariate Analysis of Variance.

Univariate Analysis of Variance (ANOVA) table

Table No. 2 Tests of Between-Subjects Effects

Dependent Variable: TOTAL SCORE

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	83031.683a	30	2767.723	29.248	.000
Intercept	76771.655	1	76771.655	811.293	.000
INT	15803.975	1	15803.975	167.010	.000
CLASS	1439.692	1	1439.692	15.214	**.000
RU	10748.097	1	10748.097	113.582	**.000
P.PROFESSION	521.845	3	173.948	1.838	NS.139
GENDER	1009.202	1	1009.202	10.665	**.001
CLASS * RU	57.733	1	57.733	.610	NS.435
CLASS * P.PROFESSION	386.399	3	128.800	1.361	.NS253
CLASS * GENDER	19.273	1	19.273	.204	NS.652
RU * P.PROFESSION	323.797	3	107.932	1.141	NS.332
RU * GENDER	63.162	1	63.162	.667	NS.414
P.PROFESSION * GENDER	1348.110	3	449.370	4.749	**.003
CLASS * RU * P.PROFESSION	896.446	3	298.815	3.158	*.024
CLASS * RU * GENDER	42.972	1	42.972	.454	NS.501
CLASS * P.PROFESSION * GENDER	633.228	3	211.076	2.231	NS.083
RU * P.PROFESSION * GENDER	135.874	2	67.937	.718	NS.488
CLASS * RU * P.PROFESSION * GENDER	203.165	2	101.583	1.073	NS.342
Error	94439.459	998	94.629		
Total	1506523.000	1029			
Corrected Total	177471.143	1028			

*------- significant at 5% level of significance.

**------ significant at 1% level of significance and NS----- not significant.

Gender Wise Comparison of the Total sample

The data was split gender wise i.e. Boys (symbolized as 4) and girls (symbolized as 5) and ANOVA was carried out.

Table No.3

GENDER	MEAN	STD. DEVIATION	N
4	38.65	12.795	530
5	33.06	12.899	500
Total	35.94	13.139	1030

Table showing the means, S.D.s and frequencies of the independent variable Gender.

The results emerging from the analysis of data are as follows:

- The difference in total scores of geometry between the boys and girls is highly significantat 1% level of significance. Therefore the null hypothesis may be rejected. That is the mean of total scores of geometry of boys is significantly greater than that of girls.
- The interaction effects of gender with class, and gender with location, are not significant. However, the interaction effect of gender with parents' profession is highly significant at 1% level of significance. In other words, the differences in geometric scores between the boys and girls are not affected by interaction of gender and location, but are much affected by their parents' professions.

Observation: among all students boys have performed better than girls.

Further comparisons:

For further elaboration, the sample was split class wise, location wise, and according to parents' professions.

Class wise analysis

The enabling hypotheses are:-

1. Ho(VII) –There is no significant difference between the total scores of geometry of boys and girls of class VII.
2. Ho(IX) - There is no significant difference between the total scores of geometry of boys and girls of class IX.

(ANOVA TABLE) Tests of Between-Subjects Effects

Dependent Variable: TOTAL Table no.4

CLASS	Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
7	Corrected Model	39491.120a	14	2820.794	26.411	.000
	Intercept	235628.746	1	235628.746	2.206E3	.000
	GENDER	1141.056	1	1141.056	10.684	**.001
	RU	10392.471	1	10392.471	97.306	**.000
	P.PROFESSION	816.715	3	272.238	2.549	NS.055
	GENDER * RU	1.547	1	1.547	.014	NS.904
	GENDER * P.PROFESSION	699.378	3	233.126	2.183	NS.089
	RU * P.PROFESSION	557.234	3	185.745	1.739	NS.158
	GENDER * RU * P.PROFESSION	171.023	2	85.511	.801	Ns.450
	Error	56391.613	528	106.802		
	Total	743811.000	543			
	Corrected Total	95882.733	542			

9	Corrected Model	25497.677b	14	1821.263	15.929	.000
	Intercept	191976.673	1	191976.673	1.679E3	.000
	GENDER	880.372	1	880.372	7.700	**.006
	RU	8553.283	1	8553.283	74.809	**.000
	P.PROFESSION	1621.561	3	540.520	4.728	**.003
	GENDER * RU	14.544	1	14.544	.127	NS.722
	GENDER * P.PROFESSION	2006.091	3	668.697	5.849	**.001
	RU * P.PROFESSION	1687.966	3	562.655	4.921	**.002
	GENDER * RU * P.PROFESSION	192.321	2	96.160	.841	NS.432
	Error	53851.820	471	114.335		
	Total	762712.000	486			
	Corrected Total	79349.498	485			

*------- significant at 5% level of significance.

**------ significant at 1% level of significance.

NS----- not significant.

- The difference between the total scores of boys and girls of class VII is highly significant at 1% level of significance. Hence the null hypothesis Ho (VII)may be rejected.

Thus the mean of total scores of boys is significantly greater than that of girls of class VII.

- The difference between the total scores of boys and girls of class IX is highly significant at 1% level of significance. Hence in this case the null hypothesis Ho (IX)may be rejected.

Thus the mean of total scores of boys of class IX is greater than that of girls of class IX.

Observation: In both class VII and class IX, boys have performed better than girls.

Location wise analysis

The enabling hypotheses are:

H0U : There is no significant difference between the total scores of geometry of boys and girls of urban area.

H0R : There is no significant difference between the total scores of geometry of boys and girls of rural area.

(ANOVA) Tests of Between-Subjects Effects

Dependent Variable: TOTAL SCORES Table No. 5 *--

R / U	Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
6	Corrected Model	9844.136a	15	656.276	8.192	.000
	Intercept	242178.321	1	242178.321	3.023E3	.000
	P.PROFESSION	253.572	3	84.524	1.055	NS.368
	CLASS	1690.531	1	1690.531	21.101	**.000
	GENDER	558.969	1	558.969	6.977	**.008
	P.PROFESSION * CLASS	207.003	3	69.001	.861	NS.461
	P.PROFESSION * GENDER	1825.009	3	608.336	7.593	**.000
	CLASS * GENDER	4.057	1	4.057	.051	NS.822
	P.PROFESSION * CLASS * GENDER	656.578	3	218.859	2.732	NS.043
	Error	44063.440	550	80.115		
	Total	548418.000	566			
	Corrected Total	53907.576	565			

8	Corrected Model	6173.384b	13	474.876	3.222	.000
	Intercept	210249.062	1	210249.062	1.426E3	.000
	P.PROFESSION	1217.521	3	405.840	2.753	NS.042
	CLASS	978.495	1	978.495	6.639	*.010
	GENDER	1891.478	1	1891.478	12.833	**.000
	P.PROFESSION * CLASS	1798.221	3	599.407	4.067	**.007
	P.PROFESSION * GENDER	172.541	2	86.270	.585	NS.557
	CLASS * GENDER	136.296	1	136.296	.925	NS.337
	P.PROFESSION * CLASS * GENDER	170.927	2	85.463	.580	NS.560
	Error	66179.994	449	147.394		
	Total	958105.000	463			
	Corrected Total	72353.378	462			

----- significant at 5% level of significance.

**------ significant at 1% level of significance.

NS----- not significant.

- The difference between the total scores of geometry of boys and girls of urban area is highly significant at 1% level of significance. Thus the null hypothesis H0U is rejected.

  Thus the total mean score of boys of urban area is greater than that of the girls of urban area.

- The difference between the total scores of geometry of boys and girls of rural area is highly significant at 1% level of significance .Thus the null hypothesis H0R is rejected.

Thus the total mean score of boys of rural area is greater than that of the girls of rural area.

Observation: In both the urban and rural area boys have performed than girls

Parents' profession wise analysis

The enabling hypotheses were:

H0 (P1): There is no significant difference between the total scores of geometry of boys and girls of P1 parents.

H0 (P2): There is no significant difference between the total scores of geometry of boys and girls of P2 parents.

H0 (P3): There is no significant difference between the total scores of geometry of boys and girls of P3 parents.

H0 (P4): There is no significant difference between the total scores of geometry of boys and girls of P4 parents.

aNova table Table no.6

P. Profession	Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
P1	Corrected Model	6072.562a	5	1214.512	21.756	.000
	Intercept	43464.307	1	43464.307	778.580	.000
	CLASS	1341.854	1	1341.854	24.037	**.000
	GENDER	17.894	1	17.894	.321	NS.572
	RU	3429.848	1	3429.848	61.439	**.000
	CLASS * GENDER	447.359	1	447.359	8.014	**.005
	CLASS * RU	392.476	1	392.476	7.030	**.009
	GENDER * RU	.000	0	.	.	.
	CLASS * GENDER * RU	.000	0	.	.	.
	Error	9099.497	163	55.825		
	Total	164703.000	169			
	Corrected Total	15172.059	168			

P2	Corrected Model	13400.424b	7	1914.346	19.417	.000
	Intercept	241160.703	1	241160.703	2.446E3	.000
	CLASS	1861.690	1	1861.690	18.883	**.000
	GENDER	1630.927	1	1630.927	16.542	**.000
	RU	7801.334	1	7801.334	79.127	**.000
	CLASS * GENDER	15.204	1	15.204	.154	NS.695
	CLASS * RU	216.486	1	216.486	2.196	NS.140
	GENDER * RU	5.903	1	5.903	.060	NS.807
	CLASS * GENDER * RU	110.627	1	110.627	1.122	NS.291
	Error	22676.366	230	98.593		
	Total	299500.000	238			
	Corrected Total	36076.790	237			
P3	Corrected Model	20004.802c	7	2857.829	26.958	.000
	Intercept	388664.166	1	388664.166	3.666E3	.000
	CLASS	185.934	1	185.934	1.754	NS.186
	GENDER	3452.958	1	3452.958	32.572	**.000
	RU	12373.498	1	12373.498	116.719	**.000
	CLASS * GENDER	161.747	1	161.747	1.526	NS.218
	CLASS * RU	1190.685	1	1190.685	11.232	**.001
	GENDER * RU	87.254	1	87.254	.823	NS.365
	CLASS * GENDER * RU	30.174	1	30.174	.285	NS.594
	Error	34347.665	324	106.011		
	Total	486715.000	332			
	Corrected Total	54352.467	331			
P4	Corrected Model	10371.215d	7	1481.602	9.470	.000
	Intercept	131319.671	1	131319.671	839.352	.000
	CLASS	122.704	1	122.704	.784	NS.377
	GENDER	7.181	1	7.181	.046	NS.831
	RU	3814.585	1	3814.585	24.382	**.000
	CLASS * GENDER	28.610	1	28.610	.183	NS.669
	CLASS * RU	12.772	1	12.772	.082	NS.775
	GENDER * RU	141.802	1	141.802	.906	NS.342
	CLASS * GENDER * RU	59.584	1	59.584	.381	NS.538
	Error	44119.906	282	156.454		
	Total	555605.000	290			
	Corrected Total	54491.121	289			

P. Profession
P1 = physical labor = 1
P2 = Skilled labor = 2
P3 = business = 3
P4 = Teacher / deskwork = 4
*------- significant at 5% level of significance.
**------ significant at 1% level of significance.
NS----- not significant.

- The difference between the total scores of geometry of boys and girls of P1 parents is not significant .Thus the null hypothesisH0 (P1) is accepted.

  Thus the mean of the total score of girls of P1 parents is greater than that of the boys of P1 parents.
- The difference between the total scores of geometry of boys and girls of P2 parents is highly significant .Thus the null hypothesisH0 (P2) is rejected.

  Thus the total mean score of boys of P2 parents is greater than that of the girls of P2 parents.
- The difference between the total scores of geometry of boys and girls of P3 parents is highly significant .Thus the null hypothesisH0 (P3) is rejected.

  Thus the total mean score of boys of P3 parents is greater than that of the girls of P3 parents.
- The difference between the total scores of geometry of boys and girls of P4 parents is highly significant .Thus the null hypothesis H0 (P4)is rejected.

  Thus the mean of total score of boys of P4 parents is greater than that of the girls of P4 .

Observation: Among all the four parents' profession, girls of P1 parents have performed better than that of the boys of P1 parents, whereas boys of P2, P3, and P4 parents have performed better than that of the girls of P2, P3, and P4 parents.

V. SUMMARY OF THE RESULTS

The results have been summarised in the following table.

The sample was split class wise, location wise, and according to parents' profession, and examined, revealing similar results.

The findings of the above hypotheses are shown in the following table:

Table No. 7

All Students	Class	Location	Parents' Profession
** Boys Girls	VII (**) Boys Girls	Urban (**) Boys Girls	P1(**) Girls Boys
	IX(**) Boys Girls	Rural (**) Boys Girls	P2 (**) Boys Girls

** ----- significant difference at 1% level of significance.

observation: In all the subgroups boys performed better than girls except for the students of parents with P1 profession where girls performed better than boys.

The investigator also compared the total scores of geometry between the boys and girls of class VII and class IX and it was found that boys' geometry concept acquisition is significantly greater than that of girls. It was also found that among all the sub samples i.e. class, location, and parents' profession boys outperformed girls. A Survey of literature shows that the reason may be lack of confidence and anxiety among the girls (Pomerantz, Altermatt, & Saxon, 2002 Eccles & Jacobs, 1986; Else-Quest et al., 2010; Ma & Cartwright, 2003; Meece et al., 1990; Tocci& Engelhard, 1991). Also the effect of social environment cannot be ignored in this regard, where the girls are encouraged to avoid science based subjects and discouraged to develop interest in math.

VI. DISCUSSION

The present study serves to reinforce the idea of boys being more proficient in geometry and the handling of visual ideas in our society. This state of affairs has the potential of debaring girls from pursuing avocations related to maths and closes many career paths to them.

Though various researches have shown the role of gender in the acquisition of basic geometric concepts, some findings show no significant difference between boys and girls in the acquisition of basic geometric concepts. a pertinant e ample of this is the study by Halat (2006). This study e mined the acquisition of the Van Hiele levels of teaching geometry (1958) and motivation of sixth-grade students engaged in learning, using van Hiele theory-based mathematics curricula. Halat demonstrated that there was no statistically significant difference as in motivation between boys and girls, and that no significant difference was detected in the acquisition of the levels between boys and girls. In other words, gender was not a factor in learning geometry.

On the contrary, among spatial measures, the largest sex difference was found on mental rotation tasks, which required the ability to hold images in one's mind while mentally manipulating them (Vandenberg & Kuse, 1978). On these tasks, males tended to outperform females in both accuracy and speed (e.g., Masters & Sanders, 1993).

Recent studies also suggest sex differences on certain tasks involving mental rotation emerge in young children; however, the differences become more noticeable starting in middle-school and further increases through the college years (Geiser, Lehmann, & Eid, 2008; Levine, Huttenlocher, Taylor, & Langrock, 1999; Voyer et al., 1995).

Numerous studies have found that females are less confident than males in their mathematical abilities (Catsambis, 1994; Else-Quest,Hyde, & Linn, 2010; Herbert & Stipek, 2005; Hyde, Fennema, Ryan, Frost, & Hopp, 1990; Meece et al., 1990; Sherman, 1980). This relative lack of confidence has been documented even in samples of students, in which girls obtain higher math grades than boys (e.g., Pomerantz, Altermatt, & Saxon, 2002).

The differences in math confidence are mirrored by sex differences in math anxiety, with most investigators reporting higher anxiety in females, compared to males (Eccles & Jacobs, 1986; Else-Quest et al., 2010; Ma & Cartwright, 2003; Meece et al., 1990; Tocci & Engelhard, 1991). For both math confidence and anxiety, the developmental trajectory shows an increase in sex differences from middle to high school and further into the college years (Hyde et al., 1990).

Much research has gone into investigating the gender differences in the acquisition of visual spatial abilities. School geometry is expected to directly nurture visual - spatial abilities, though literature seems to indicate that boys are more proficient in this area. Whether there is really any difference in the acquisition of geometric ideas by boys and girls in our culture is worth investigation. Also, it may be interesting to find out whether this disparity (if any), increases or decreases over the years in middle school.

We teach plenty of geometry in school, but we are not always aware that many children do not acquire the basic concepts of geometry. This study can act as a guide for teachers and curriculum makers so that vulnerable aspects of geometry learning in school can be attended to and cognition of spatial ideas can be well rooted in young minds.

The study shows that boys outperform girls in the acquisition of basic geometric ideas. But many research findings showed that the gap between boys and girls in this regard, is closing. If girls are encouraged in their studies, especially in subjects like mathematics, then they will be more motivated to develop their visual spatial skills. More examples which interest girls and encourage them to think rationally must be discussed that girls can build up confidence about their potentialities.

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