Research Paper Education

# A study of the Effect of Personal and Institutional Variables on Mathematics Achievement of Secondary School Students

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ABSTRACT

*This study explored the effects and relationship of personal (gender, attitude towards mathematics, socioeconomic status, usage of computer, internet browsing, TV watching, participation in sports activities, participation in extracurricular activities) and institutional (school climate, location of schools, medium of instructions and teacher-pupil ratio) variables on mathematics achievement of secondary school students. A convenience sample of 1944 students, 975 males and 969 female from thirty six schools of South-East Bihar (India) was used for study. The Mathematics Achievement Test, Mathematics Attitude Scale, School Climate Scale, Personal Background Assessment Questionnaire and An Institutional Background Assessment Questionnaire were used for data collection, while t-test, F-test followed by Duncan's Mean Test, correlation coefficient stepwise multiple regression techniques and percentage were used for statistical analysis. The results revealed that there was a significant difference between mathematics achievement of boys and girls. Further this study showed a positive correlation of attitude, attitude towards mathematics, socioeconomic status, usage of computer, internet browsing, TV watching, participation in sports activities, participation in extracurricular activities, school climate and medium of instruction with mathematics achievement.*

Keywords : Mathematics Achievement, Gender, Attitude, School Climate, Location of Schools, Teacher Pupil Ratio

Education is described by Kirk and Gallagher (1983:34) as the mirror of the society, showing its strengths, weaknesses, hopes, biases and key values of its culture. Thus, education has a definite role to play in the development of people and countries. Education plays a significant role in the development of people because people are the wealth of any nation; therefore, people are viewed as a focus for development. It plays a vital role in the development of the country because education is the source of growth of any country. This may be one of the reasons why United Nations Educational Scientific and Cultural Organization (UNESCO) (2001:9) declare education a vehicle for and indicator of development.

Achievement in mathematics is the stage of attainment in mathematics by the students, generally expressed in terms of grade or scores. It is defined as performance of students in mathematics tests based on scores. Achievement test is used to measure the degree of mastery of skills, fundamental concepts, process and general knowledge of subject. All educational tests are actually are generally achievement test used for certain purposes. According to tenaja (1989), achievement refers to performance in a particular subject or in the whole curricular that is measured by school examination or test. In this study, achievement in mathematics has been studied as knowledge, skill, comprehension & application attained in the mathematics.

The world is becoming more and more competitive and quality of performance has become the key factor for personal progress. Parents desire that their children climb the ladder of performance to as high level as possible. This desire of a high level of achievement put a lot of pressure on students, teachers and institutions; in general the educational system itself. In fact it appears as if the whole system of education revolves around the academic achievement of the students, through various other outcomes are also expected from the system. Thus a lot of time and efforts of the schools are helping students to achieve better in their scholastic endeavors. The importance of scholastic achievement has raised several important questions for educational researchers. What factors promote achievement in students? How far do the different factors contribute towards academic performance? Therefore many factors have been hypothesized and researched upon and researchers have come out with different results, at time, complementing each other but at times contradicting each other.

A complete and comprehensive picture of academic achievement still seems to eluding the researchers. The search therefore continues and educational researchers all over the world are still seeking a breakthrough in elucidating this phenomenon. Therefore research has come to our aid by looking into what variables like personal, institutional factors etc. promote academic achievement and what are the determinants to it.

It has been thus indicated that a good number of variables such as personality characteristics of the learner, the socio-economic status, the institutional resources, climate, curriculum planning etc. mention a few exert influence on mathematics achievement in different degrees. These variables are generally refers to as correlates of achievement. Head of the institutions, Curriculum planners, teachers and others are involved in the task of helping students to achieve better would like to have knowledge of the extent of influence of these correlates on academic performance in mathematics.

Let us find out the position of mathematics in our school curriculum in the last two or three decades. Most of the boards of secondary education in India prescribed two types of mathematics syllabuses for the students of 10-years schools, one being elementary or general mathematics which was an additional mathematics course for the student having special aptitude and interest in math-

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ematics. The Central Board of Secondary Education had of course two different syllabuses in mathematics one at A level and another at B level. The student should choose any one of the two syllabuses. The Central Board has dispensed with the dual syllabi from the examination year 1986 and has prescribed only one syllabus irrespective of attitude, ability and aptitude of the students.

The purpose of this study was to examine the relationship of mathematics achievement (dependent variable) with personal (gender, attitude towards mathematics, socio-economic status, usage of computer, internet browsing, TV watching, participation in sports activities, participation in extracurricular activities) and institutional (school climate, location of schools, medium of instructions and teacher-pupil ratio) (independent variables) of secondary school students of South-East Bihar (India).

**The research questions for this study include the following:**

1. Do genders explain differences in the mathematics achievement?
2. Do the personal variables affect the mathematics achievement?
3. Does the school climate correlate the mathematics achievement?
4. Does the location of schools affect the mathematics achievement?
5. Do the personal and institutional variables correlate the mathematics achievement?
6. Do the institutional variables affect the mathematics achievement?
7. Does the teacher pupil ratio explain differences in the mathematics achievement?

**Method:**
The present work is a descriptive study investigating if students' mathematics achievement differed significantly to a group of variables such as personal (gender, attitude towards mathematics, socioeconomic status, usage of computer, internet browsing, TV watching, participation in sports activities, participation in extracurricular activities) and institutional (school climate, location of schools, medium of instructions and teacher-pupil ratio). The sample consisted of 1944 students of class IX, selected from 36 schools of South-Bihar (India) in which 975 were male and 969 were female students. In this study, schools were categorized on the basis of their locations eg. Urban schools, Semi-urban schools and rural schools.

**Tools Used:**
**Mathematics Achievement Test**
The achievement test in mathematics for class IX students that is used in the present study was constructed by the investigator. This is a very comprehensive test based on 12 common chapters of class VIII mathematics text book (NCERT, New Delhi and Bihar State Education Board, Patna). The test consists of 70 items of multiple choice type representing achievement at various areas of mathematics such as 27 items in arithmetic, 21 items in algebra and 06 items in geometry, 12 items in menstruation and 4 item in statistics. The total score on the test as a whole was used as a measure of achievement in mathematics. All the items in the test were arranged in order of difficulty, the easy items being placed in the beginning and this was done to motivate the students. The difficulty values of items in the test between the range of 0.25 to 0.85 similarly, each item had a discriminating power greater than 0.30. The test was based on the latest syllabus prescribed by the NCERT, New Delhi and Bihar State Education Board, Patna. This test had a fairly high content validity and its reliability is found to be 0.90.

**Mathematics Attitude Scale**
This attitude scale consists of 22 statements of Likert type representing attitudes towards various aspects of mathematics such as enjoyment of mathematics, value of mathematics, mathematics anxiety, success in mathematics, mathematics as male domain, usefulness of mathematics, confidence to learn and evaluation. The reliability of coefficient of the attitude scale is 0.90 as reported by the developer and as calculated by split-half method. It is found to discriminate sufficiently between students of high attitude and those of low attitude. This scale appears to have high content validity and the method of selecting items supports this position. The range of scores on this tool extends from 22 to 110 with the mean of 66. The summation of score earned by a student on all statements was taken as his attitude score. The total scores indicate favorableness or unfavourableness of the attitude of students towards mathematics. The higher is the score the more favorable is the attitude towards mathematics and lower is the score the more unfavorable is the attitude towards mathematics of the students.

**School Climate Scale:**
This climate scale consists of 18 statements of Likert type representing various aspects of climate in school such as freedom, cooperation, motivation, enjoyment of schooling, discipline, health and hygiene, fee structure, equal opportunities, support of faculty and administration. The reliability of coefficient of the school climate scale is 0.89 as reported by the test developer. It is found to discriminate sufficiently between open and healthy climate of school and those of closed and worst climate. This scale appears to have content validity and the method of selecting items supports this position. The range of scores on this tool extends from 18 to 90 with the mean of 54. The summation of score earned by a student on all statements was taken as school climate score. The total scores indicate favorableness or unfavourableness of the climate of school. The higher is the score the more open and healthy climate in the school and lower is the score the more closed and worst climate in the school.

**A Personal Background Assessment Questionnaire**
The personal information sheet is prepared by the investigator. This sheet contains such questions requiring the subjects to give information on their medium of instruction in the school as well as students' involvement in internet browsing as well as participation in sports activities etc.

**An Institutional Background Assessment Questionnaire:**
This questionnaire is used to gather information's regarding the schools like qualification of the teachers, teachers training, teachers experience, school type and location of the school, etc.

**Table 1 Comparison of mean mathematics achievement scores of male and female students**

| Gender | N | Mean | SD | df | t-value | Sig./Not sig. |
|---|---|---|---|---|---|---|
| Male | 975 | 45.81 | 14.71 | 1942 | 2.40* | Sig. at 0.05 level |
| Female | 969 | 44.19 | 15.13 | | | |

* Significant at 0.05 level

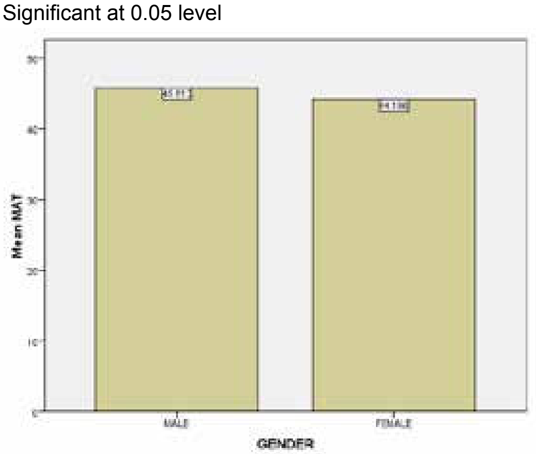


**Fig. 1 Gender wise graphical presentation of mean mathematics achievement score**

The total numbers of male and female students were 975 & 969 respectively as indicated by the table 1. Out of 70 scores, the mean achievement scores in mathematics of male student is 45.81 and standard deviation (SD=17.41), in case of female students, the mean mathematics achievement score is 44.19 and standard deviation (SD=15.13). The statistically calculated t-value is 2.40; which is significant at 0.05 level with 1942 df. The result clearly indicates that there is significant difference between mean mathematics achievement score of male and female secondary school students. Both are not equally good they differ in their mathematics achievement. Thus the first hypothesis stating that "Male and female students do not differ significantly on mathematics achievement" is rejected at 0.05 level of confidence. The graphical presentation of mean mathematics achievement scores of both sexes is given in fig. 1

**Table 2 Determinants of mathematics achievement score and personal factors**
**(N=1944)**

| Independent Variables | Dependent Variable (MAT) | | |
|---|---|---|---|
| | Beta | Simple R | t-value |
| Attitude towards mathematics | 0.25** | 0.2928** | 11.82 |
| Socioeconomic status | 0.25** | 0.2912** | 12.18 |
| Participation in sports activities | 0.05* | 0.1570** | 2.66 |
| Multiple R= 0.40<br>R Square = 0.16 | | | |

*Significant at 0.05 level, **Significant at 0.01 level

Gender, attitude towards mathematics, socioeconomic status, usage of computer, internet browsing, television watching, participation in sports activities and extracurricular activities were used in a stepwise multiple regression analysis to predict achievement in mathematics of secondary school students. The correlations, beta score and t-value is given in table 2.

The predictor model contained three of eight predictors and was reached in three steps with no variables removed. The model was statistically significant at .01 level and accounted for 40% of the variance of mathematics achievement.

Mathematics achievement was primarily predicted by higher level of attitude towards mathematics, socioeconomic status and participation in sports activities. The raw and standardized regression coefficients of the predictors together with their correlations with mathematics achievement attitude towards mathematics received the strongest weight in the model followed by socioeconomic status and participation in sports activities received the lowest of the three weights. Hence the hypothesis stating that "there is no significant personal variable which affect the mathematics achievement of students" was rejected.

**Table 3 Relationship of school climate and mean mathematics achievement scores of secondary school students**

| Variables | N | Mean | SD | Correlation Coefficient (r) |
|---|---|---|---|---|
| MAT | 1944 | 45.00 | 14.94 | 0.2135** |
| SCS | 1944 | 39.63 | 14.17 | |

** Significant at 0.01 level

The analysis was employed to find out the relationship of school climate and achievement in mathematics. The total samples were 1944. The mean scores and standard deviations of achievement in mathematics and school climate of secondary school students were found to be 45.00 & SD= 14.94 and 63.46 & SD= 14.17 respectively. The correlation was applied for investigation, the mean scores, standard deviations and correlation coefficient (r) values are given in table 3. The analysis does not confirm the prediction hypothesized in this study for the present sample. A strong relationship between school climate and achievement in mathematics has been demonstrated by this finding. Hence, the hypothesis stating that, "there is no significant relationship between school climate and mathematics achievement of secondary school students" was rejected at 0.01 level.

**Table 4 Summary of analysis of variance in respect to mathematics achievement and location of schools**

| Source of variance | df | Sum of squares | Mean square | F-value | Sig. level |
|---|---|---|---|---|---|
| Between groups | 2 | 23130.86 | 11565.43 | 54.69** | 0.01 level |
| within groups | 1941 | 410480.14 | 211.48 | | |
| Total | 1943 | 433610.99 | | | |

** Significant at 0.01 level

**Table 5 Comparison of mathematics achievement scores among the three categories of location of schools ($L_1$=Urban, $L_2$= Rural, $L_3$= Semi-urban) of secondary school students**

-Duncan's Mean test

| Urban $L_1$ (N=935) | | Rural $L_2$ (N=568) | | Semi-Urban $L_3$ (N=441) | | Significant pairs (*) | F-value |
|---|---|---|---|---|---|---|---|
| Mean | SD | Mean | SD | Mean | SD | | |
| 48.29 | 11.99 | 40.28 | 16.85 | 44.11 | 16.16 | $L_1$ Vs $L_2$<br>$L_1$ Vs $L_3$<br>$L_2$ Vs $L_3$ | 54.69** |

** Significant at 0.01 level

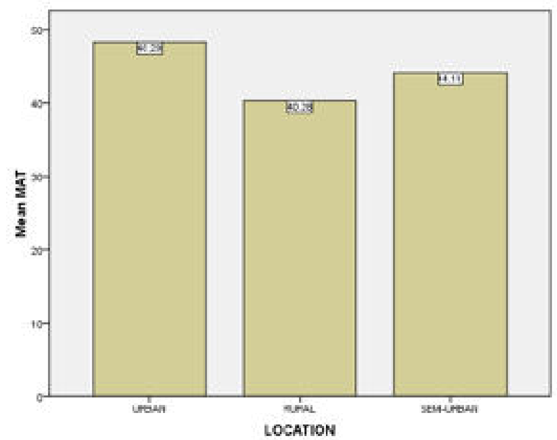


**Fig. 2 Graphical presentation of mean mathematics achievement score on the basis of the location of schools**

The analysis of variance was employed to find out the influence of location of schools of students on mathematics achievement. The total samples were categorized into three groups i.e. urban, rural and semi-urban on the basis of their locations. The mean achievement scores of three groups of urban, rural and semi-urban of students were found to be 48.29, 40.28 and 44.11 respectively. The total sums of squares between and within means were computed. Analysis of variance of the mathematics scores of the three group yielded F value as 16.16 which is significant at .01 level with df 2, 1941 (table 4). This implied that there is significant overall difference in the means of these groups. Hence F test was found significant therefore Duncan's post hoc test was applied for further investigations.

Further support to this conclusion, it is also provided by a test of significance of difference between the mean mathematics achievement scores of the three types of groups of location of schools as given in the table 5.

The statistical method used in testing the major hypothesis was the Duncan's post hoc test for the difference between the means of three groups. The significant pairs obtained by comparing each group mean mathematics achievement score with that of every other group shows that out of three groups all the three pairs of groups are found to be significant. Further the table 5 shows that students of group of semi-urban group have the highest mathematics achievement scores than the other two groups and then students of urban group have higher mathematics achievement scores than rural students group.

These analyses do not confirm the prediction hypothesized in this study for the present sample. A relationship between mathematics achievement scores of students and location of schools has been demonstrated by the findings. Hence the hypothesis stating that, "there is no significant difference among the categories of location of school and mathematics achievement of secondary school students" was rejected. The fig 2 shows the mean scores of mathematics achievement of students of three groups of location of schools.

Table 6 Relationship (correlation coefficient) of independent variables with dependent variable (Mathematics Achievement Score) (N=1944)

| Independent Variables | Dependent Variable |
|---|---|
| | MAT |
| Gender | 0.0545** |
| Attitude towards mathematics | 0.2928** |
| Socioeconomic status | 0.2912** |
| Use of Computer | 0.1017** |
| Internet Browsing | 0.1131** |
| TV watching | 0.0280* |
| Participation in sports activities | 0.1570** |
| NCC/NSS Activities | 0.0857** |
| School climate | 0.2135** |
| Medium of Instruction | 0.3628** |

*Significant at 0.05 level, **Significant at 0.01 level

The table 6 shows that achievement in mathematics is positively and significantly correlated with the ten independent variables under study. It correlates 0.0545** with gender, 0.2928** with attitude towards mathematics, 0.2912** with socioeconomic status, 0.1017** with use of computer, 0.1131** with internet browsing, 0.1570** with participation in sports activities, 0.0857** with NCC/NSS activities, 0.2135** with school climate and 0.3628** with medium of instructions at 0.01 level of significance. The achievement in mathematics correlates 0.0280* with TV watching at 0.05 level of significance.

Hence the achievement in mathematics is positively and significantly correlated with all the ten independent variables.

**Table 7 Determinants of Mathematics Achievement Score and institutional factors**
**(N=1944)**

| Independent Variables | Dependent Variable (MAT) | | |
|---|---|---|---|
| | Beta | Simple R | t-value |
| TPR | -0.45 | 0.456** | 2.99 |
| Multiple R= 0.456<br>R Square = 0.208 | | | |

**Significant at 0.01 level

At first the mean mathematics achievement scores are computed according to school wise then this mean mathematics achievement scores are estimated as the scores of that particular school and further analysis for t-value is done.

School resources, number of mathematics teachers, teacher pupil ratio, school climate were used in a stepwise multiple regression analysis to predict achievement in mathematics of secondary school students. The correlations, beta score and t-value is given in table 7.

The predictor model contained one of five predictors and was reached in one step with no variables removed. The model was statistically significant at .01 level and accounted for 45.6% of the variance of mathematics achievement.

Mathematics achievement was only predicted by teacher pupil ratio. The raw and standardized regression coefficients of the predictor together with the correlation with mathematics achievement received the strongest negative weight in the model. Hence the fifteenth hypothesis stating that "there is no institutional variable which affect the mathematics achievement of students" was rejected.

**Table 8 Percentage table of teachers and students ratio of the class in various types of schools and mean mathematics achievement of the children of respective schools**

| School Type | Students | Mean | SD | Min | Max | Teachers | | Students | | Teacher Student Ratio |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | N | % | N | % | |
| Central Govt. | 444 | 52.37 | 10.46 | 26 | 68 | 184 | 22.55 | 3245 | 11.32 | 1:18 |
| State Govt. | 500 | 30.92 | 12.45 | 2 | 58 | 205 | 25.37 | 12751 | 44.48 | 1:63 |
| Minority Managed | 500 | 48.44 | 9.71 | 11 | 68 | 220 | 25.12 | 5136 | 17.92 | 1:24 |
| Private Managed | 500 | 49.10 | 15.70 | 1 | 68 | 207 | 26.96 | 7535 | 26.28 | 1:37 |
| Total | 1944 | 45.00 | 14.93 | 1 | 68 | 816 | 100 | 28667 | 100 | 1:36 |

As regards to teacher-public ratio, the same was calculated in four types of schools and then compared with each other. These types of schools like central government, state government, private managed and minority managed schools were found to differ on teacher pupil ratio (table 8). The teacher pupil ratio in central government schools was found to be 1:18 and in minority managed schools this ratio was 1:24 then this ratio was in private managed schools, 1:37 as comparison to state government schools where it is very high i.e. 1:63. Table 8 shows that there is difference among all four groups. The mean scores make it clear that the student of low teacher-pupil ratio achieved higher score than the higher teacher pupil ratio.

**Discussion:**
There was significant difference in mathematics achievement scores between boys and girls in the present study. The finding of this study is supported by Asante, K Oppong (2010),

Forgasz, Helen (2010) found that generally female students attained higher grades in all other school subjects besides mathematics, science and IT than their male counterparts. Gender differences and the findings on gender differences in mathematics achievement are not newly emerged fact. long research history in this area has demonstrated that male advantage in mathematics achievement is a universal phenomenon (Beaton et al, 1996; Mullis et al., 2000). Researchers have shown that boys tend to score higher than girls on problems that include spatial representation, measurement, proportions as well as complex problems; whereas girls tend to score higher on computations, simple problems and graph reading (Beaton et al. 1999) According to some research findings, the gender gap in mathematics achievement increases during middle school and becomes more disturbing at the upper secondary level (Fennema et al. 1998; Fennema, 1985). Friedman (1989) noted that until age 10 either no differences between genders or favoring girls are observed. He observed that 12th grade boys out performed girls, finally, other studies (Fox, Brody & Tobin, 1980) emphasized high mathematics achievement being dominated by males. Deder (1992) has also reported the existence of gender differences in science subject in general as well as in mathematics but Branholt, Goodraw & conney (1999), Ewers & Wood 1992; Skaalvik, 1990; hilton & Berglund (1974). Awartani and Gray (1989) reported no significant differences between male and female students in mathematics achievement. Ma (1995) studied a sample of high school seniors, based on algebra and geometry achievement. He found no gender differences in algebra but males significantly outperformed females in geometry. Gender differences in achievement, especially mathematics, have not been consistent and continue to be a much debated topic (leder, 1992).

When data was analyzed to see the significant difference in mathematics achievement scores on the basis of location of the schools, it is found that students of urban areas schools achieved significantly more achievement score in mathematics than the students of rural and semi-urban schools. It is clear that urban schools have good facilities as compare to rural and semi-urban schools. This result is supported by Ojha (1979) reported that achievement of rural boys was found to be better than urban students.

It has been found that class size was related to the achievement in mathematics. This can be explained as, when the teacher pupil ratio is low (small class), the mathematics performance is high and on the other hand, when the teacher pupil ratio is high (larger class) i.e., ratio of students with respect to teacher is high, the achievement in mathematics of students is significantly low such findings corporate with the results of Bastier sigitha (1994), padan (1988), Duraiswamy (1999) and Satvir and Saxena (1995). Angirist and lavy (1999), Lee and smith (1997), Monk (1987), Lee and Smith (1995), Jencks and Brown (1975), Krueger (1999).This study recommends that the appropriate pupil teacher ratio may be helpful in improving the mathematics achievement.

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