Chapter 5

Study of Factors Affecting Educational Performance in Primary Schools: Multivariate Analyses

5.1 Introduction

In the previous chapter bivariate analysis was preferred to find the effect of selected variables on the dependent variable. Literature on linear regression models reveals that the inclusion of more predictor variables tend to reduce the size of disturbances $\epsilon_i$ and the residuals $e_i$. A more important advantage is that the inclusion of more predictor variables tends to reduce bias of regression coefficient (Retherford and Choe, 1993). To avoid this situation, we prefer to go for multiple regression models in order to obtain precise estimates of regression coefficient of selected predictors. In this chapter, section I provides multiple regression analysis and section II provides multiple classification analysis.

5.2 Section I: Multiple Regression Model Analysis

A multivariate model is constructed for causal analysis to find the determinants of quality of education controlling the effects of socioeconomic variables pertaining to the background of students of different type of management system. The general multiple regression model is defined as follows

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots \ldots + \beta_k X_{ki} + \epsilon_i$$ (1)

Where $k$ denotes the number of predictor variables and $i$ denotes the $i$th member of the population. The corresponding estimated model pertaining to a particular sample from the population, is

$$Y_i = b_0 + b_1 X_{1i} + b_2 X_{2i} + \ldots \ldots + b_k X_{ki} + e_i$$ (2)

For equation (1) and (2) to serve as a statistical model, we need to invoke again the assumptions of linearity, homoscedasticity, and independence. “Linearity” means that the mean of
disturbances is zero at each combination of the predictor variables; that is $E(\varepsilon) = 0$ at every point $(X_1, X_2, \ldots, X_k)$. “Homoscedasticity” means that the variance of $\varepsilon$ is the same for each combination of the predictor variables; That is $\text{Var}(\varepsilon) = \sigma^2$ at every point $(X_1, X_2, \ldots, X_k)$. “Independence” again means that the $\varepsilon_i$ are statistically independent.

### 5.2.1 Rational of selection of the dependent and predictor variables

To determine quality of primary education the explanatory variables is considered as ‘Quality of School Education’; which is measured using academic achievement of students. The predictor variables are type of school management, student-teacher ratio, log of monthly income of household, completed years of father’s education.

#### A. Dependent variable

**Quality of Educational Result**

Result of school is a good indicator of quality of education. The final result of schools is the best indicator to judge quality of school, which is measured using final results of students. Therefore the dependent variable, quality of education of primary schools was measured on the interval scale by taking actual marks obtained by students. The final results from 24 schools having 11,484 students (class 1 to class 7) were analyzed for the academic year 2010-2011. Accordingly each school was assigned the percentage of students who secured 60% or more marks. The results of final examinations have been analyzed. Quality of education of schools was measured based on the percentage of students who secured 60% or more marks in each type of school management in Navi Mumbai;

#### B. Predictors

(i) **Type of School Management**

Good management in school plays a vital role in the quality of education. It enables teachers to contribute most efficiently by providing training, introducing skill improvement programmes, which may increase their knowledge that helps making their students grasp the subject more effectively. It may also promote individual development, discipline and may raise their self confidence and understanding. The main role of school management is
effective planning, strategy and vision to improve the academic, physical and social development of students. School managements’ responsibility is to develop a positive culture that helps to enhance the quality of education. Therefore school management is very important factor in facilitating quality education in schools. Two types of school management namely public and private were considered for multiple regression analysis.

(ii) **Student Teacher Ratio**

Student-teacher ratio is considered a good indicator of quality of education. A low student-teacher ratio suggests greater opportunity for students and teachers to be more interactive in the class. Also, students can discuss their problems and difficulty in their courses with their teachers quite often. The ratio of students to teaching staff is obtained by dividing total number of students in a school by the total number of teaching staff.

(iii) **Monthly Income of household**

Higher income household can provide better environment for study, reading material such as informative books and laptop etc. Parents can afford fees for the best school. They can provide coaching in extracurricular activities to develop overall skill of their child. This is the way household income can play a significant role in learning and creating awareness in the student.

The income values were transformed in natural logarithm function to improve the linearity. Transforms are usually applied so that the data appear to more closely meet the assumptions of a statistical inference procedure that is to be applied, or to improve the interpretability, visualization or appearance of graphs. In regression analysis, sometimes transformation of variables improves the linearity in the regression model.

(iv) **Father’s education**

There are evidences that the children whose parents are educated performed better than others at least at primary level. There is influence of father’s education on child’s learning outcomes. The parent's involvement in a child's education makes a very positive difference. Therefore father’s education is an important variable which is positively correlated with
academic achievement of their children. The number of completed years of education was considered as a significant variable in the multiple regression analysis.

5.2.2 Type of Variables

The four variables included in the Multiple regression model were (a) Type of school management; (b) Student-teacher ratio; (c) Log of household income; and (d) Completed years of father’s education.

There were three continuous variables namely student-teacher ratio, household income, and completed years of father’s education and one categorical variable. The, dummy variables have been created for categorical variable ‘Type of School Management’ as follows:

The two categories of type of management were defined as

Type of school management =0, if Private School  (reference category)

=1, if Public School

5.3 Results

Table 5.1 displayed the results of regression analysis among the four factors namely type of school management, student-teacher ratio, household income, and completed years of father’s education. The results were generated by the multiple regression program in SPSS. The results were obtained by substituting appropriate combinations of ones and zeros for ‘type of school management’ and actual data for other three variables to get the regression equations.

The type of school management had undoubtedly came out as a dominant variable affecting the quality of education (performance of students). The next variable which seems to have affected the quality of education was father’s education. The student-teacher ratio and log of household income were other significant predictors in determining the quality of education. The results indicated that the relation between quality of education was due to differences in type of school management, father’s education, student teacher ratio, and monthly income of households.
The adjusted R square gives the proportion of dependent variable or how relevant the equation is. It showed that 87% of the variations in quality of education could be explained by the predictors.

The analysis of variance (ANOVA) revealed that the significance value of $F$ i.e. $p< 0.05$, therefore the quality of education can best be predicted by the following equation.

\[
\text{Quality of education} = 79.69 + 27.67(\text{type of school}) - 0.22(\text{students-teacher ratio}) + 4.11(\text{Household income}) + 3.79(\text{Father’s education})
\]

**Table 5.1: Multiple Regression Analysis**

**Model Summary (a)**

<table>
<thead>
<tr>
<th>Mode 1</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.945(a)</td>
<td>.894</td>
<td>.871</td>
<td>3.87490</td>
</tr>
</tbody>
</table>

a Predictors: (Constant), completed years of father's education, students-teacher ratio, Log of monthly income of households, Type of school

b Dependent Variable: Performance of school

**ANOVA (b)**

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Regression</td>
<td>2400.282</td>
<td>4</td>
<td>600.070</td>
<td>39.965</td>
<td>.000(a)</td>
</tr>
<tr>
<td>Residual</td>
<td>285.282</td>
<td>19</td>
<td>15.015</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2685.564</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a Predictors: (Constant), completed years of father's education, students-teacher ratio, Log of monthly income of households, Type of school

b Dependent Variable: Performance of school

**Coefficients (c)**
The coefficients of the regression model were given in above table. The significant value of each variable was given in last column. At confidence level of 95%, the significance for each independent variable should be less than 0.05. It was found that two variables “type of school management and completed years of father’s education were highly significant (p <0.001) and other two variables viz. student-teacher ratio and household income were significant at p<0.05.

### 5.2.4 Discussion

The findings show that there was predominant effect of type of school management, and completed years of father’s education followed by student-teacher ratio and household income on quality of school education. The performance of public schools was better than private schools. All the four variables in an analysis of variance accounted for 87 percent of overall variance in quality of school education. The factor wise effect on quality of education is discussed below:

*Type of School Management*
The two types of school management public (ZP, NMMC) and private school fulfil the requirement of primary school going children in Navi Mumbai. The result shows that type of school management was a salient governing factor which has highly significant effect on quality of education in primary schools. The performance of public schools was better than that of private schools.

**Father’s Education**

The effects of parent education and home environments on school learning were significant and well documented in the research literature. The father’s education affected the academic achievement of student in positive ways with its intentional, consistent interaction with parents. It can be seen from the result of multiple regression that father’s education was strongly related to academic achievement of his child. Our findings are in conformity with Penda and Jena (2000), Pandey (2008).

**Student -Teacher Ratio**

The findings showed that the schools having lower student-teacher ratio performed better as compared to the schools which had higher student-teacher ratio. Usually, the theoretical concept is that lower student-teacher ratio produces higher level of academic achievement, and higher student-teacher ratio produces the lower level of academic achievement. This holds true in this case because the negative sign means that lower student-teacher ratio and higher academic achievement. The academic achievement is inversely proportional to student-teacher ratio. The average student-teacher ratio in public school was lower than that of private schools. A few studies have reported the positive effect of student – teacher ratio on academic performance of student. (see Alderman, Orazem & Paterno, 2001; Graddy and Stevens, 2003).

**Household Income**
The findings revealed that students’ academic achievement and educational attainment was affected by household income in positive direction. A child from a well educated family with high socio-economic status is more likely to perform better than a child from an illiterate family. This is because the child from an educated family has a good economic support such as a decent and good environment for academic work, parental support and guidance, enough textual and academic materials and decent feeding. He or she is likely to be sent to good schools where well seasoned teachers will handle his/her subjects (Onocha, 1985). Higher income can provide better environment for study, reading material such as informative books and computer etc. Parents may afford fees for the best school.

The findings revealed that the, type of school management, father’s education student-teacher ratio and household income affects the quality of education. It has been observed that the quality of education was better in public schools than that of private schools.

5.3 Section II: Multiple Classification Model and Analysis (MCA)

In the previous section, the quality of education was regressed on four predictor variables, namely, type of school management, student - teacher ratio, father’s education and household income. The effect of each of these four predictor was found using multiple regression model. In order to examine the suitability of the selected multiple regression model, the researcher calculated the multiple correlation matrix from data used for selected predictor variables type of school management, student - teacher ratio, father’s education and household income. Let $X_1$ (completed years of father's education), $X_2$ (students-teacher ratio), $X_3$ (household income) and $X_4$ (type of school management) the correlation between $X_1$ and $X_2$ is $r_{12} = -0.67$, similarly $r_{13} = -0.13$, $r_{14} = -0.18$, $r_{23} = -0.98$, $r_{24} = -0.85$, $r_{34} = -0.39$. The predictor variables student – teacher ratio and type of school management were highly correlated with correlation coefficient $r > 0.8$. This means the presence of multicollinearity in the selected multiple regression model.

Multicollinearity

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1 Two predictor variables are multicollinear if they are highly correlated. Equations are solvable if two variables are highly but not perfectly correlated (Retherford and Choe, 1993).
If the two variables X and Y are highly correlated and if the regression equations are solvable (i.e. the matrix is not singular), the estimates of the regression coefficients are imprecise in that case they have large standard errors. To overcome the effect of multicollinearity to some extent we prefer to use Multiple Classification Analysis (MCA), since it is regression with dummy variables. The data in interval scale, if made categorical by pooling it in to different categories, the magnitude of the correlation between selected predictors reduces and thus the effect of multicollinearity in the regression is minimized.

5.3.1 Multiple Classification Analysis (MCA)

MCA is a statistical technique for examining the interrelationship between several categorical predictor variables and a dependent variable. It determines the effects of each predictor after controlling the effect of other remaining predictors in the MCA model. In the present study, in order to know the contribution of each of the above selected variables/factors, Multiple Classification Analysis\(^2\) has been used with quality of education as dependent variable and the four variables/factors, namely, type of school management and student-teacher ratio were also considered because of multicollinearity and in addition to this two more variables namely percentage of trained teachers, class size as are considered as predictors. The quality of education was assessed by percentage of marks obtained by students in final examination. All the factors assumed to affect the quality of primary education were displayed in Figure 5.1.

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\(^2\) Multiple Classification Analysis (MCA) can easily be explained as multiple regression with dummy variables (Retherford and Choe, 1993).
5.3.2 Rationale of Selection of Variables

a) Dependent variable:

Quality of Education:

The quality of education was based on academic performance of student. The rationale of selecting quality of education as dependent variable was defined at paragraph A of 5.2.1; hence the rationale of selecting quality of education was not defined again.

b) Predictors:

The list of the predictors hypothesised to influence the quality of primary school education and rationale of their selection was given below

(i) Type of School Management:

The importance and role of Type of School Management’ was already discussed at paragraph B (i) at 5.2.1, therefore the same was not discussed once again.

(ii) Trained Teachers:

The teachers training is another important parameter for determining the quality of school education. It has been observed that in this new city there was shortage of trained teachers. The salaries of untrained teachers were often considerably lower than those of trained teachers. The present study, therefore, considered the percentage of
trained teachers working in the school as one of the predictor of quality of primary education;

(iii) Class Size:
The class size is defined as the actual number of students in a class assigned to an individual teacher. Information on class size is extremely valuable for assessing the quality of school education. Smaller classes allow teachers to concentrate on the needs of individual students and reducing the amount of class time they spend dealing with disruptions. Class size may affect students’ academic achievement and influence the current practical teaching situation. In this respect, class size may be viewed as an indicator of quality of school education;

(iv) Student-teacher Ratio:
Student-teacher ratio is an important indicator of quality of education. This is already discussed at paragraph B (ii) 5.2.1; hence not repeated the importance of student-teacher ratio in measuring the quality of education.

c) Covariates:
First, a regression analysis was carried out to identify the factors that had a greater influence (although not necessarily statistically significant) on quality of education. These factors were introduced into the multiple classification analysis. Furthermore, as set of covariates ‘percentage of permanent teachers’ and ‘number of year of experience in teaching’ was selected on the basis of regression analysis and were included as covariates in the model to study quality of primary school education after controlling the effects of the selected covariates. The rationale of including the two covariates in the model was given below:

(i) Percentage of Permanent Teachers in the School:
The employment status (permanent/temporary/contract basis) is a critical variable, which may influence the quality of education of school. Normally in schools the vacant posts are filled by appointing teachers on temporary or contract basis by the school management. More often, teachers are kept on temporary basis for longer
time. Such teachers may not be entitled to the benefits like those who were regular employees such as, approved pay-scale, yearly increment in salary, and job security which may indirectly affect teaching. This could cause poor quality of education.

(ii) Teaching Experience:
Experience of a teacher was another variable which may have influence on quality of education. Students’ academic achievement score may have bearing on the duration of teaching experience. With long teaching experience a teacher may quickly assess student’s requirement and can easily identify his/her difficulties in the subject.

5.3.2 Dummy Variables:

Dummy variables are vehicles which permit the researcher to handle qualitative data as a predictor in the regression model to find its effect on the dependent variable. In MCA model dummy variables are used to represent categorical/qualitative variables.

Creation of Dummy Variables:

The four categorical variables included in the MCA model were (a) Type of School Management; (b) Percentage of Trained Teacher; (c) Class Size; and (d) Student-teacher Ratio. For each of these four categorical variables, the dummy variables have been created as follows:

\( a) \) Type of School Management: Let \( S \) denotes the type of school. The three categories of types of school defined as

Private school: \( S_0 \) (reference category),

NMMMC School: \( S_1 \)

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\(^3\) In general, if a particular variable has \( r \) categories, we need to construct \( r - 1 \) dummy variables (Dillon and Goldstein 1984).
The three categories of school have 2 (i.e. 3-1) dummy variables which were defined as

\[
(S_1, S_2) = \begin{cases} 
0 = (0, 0) & \text{if private school} \\
1 = (1, 0) & \text{if NMMC school} \\
2 = (0, 1) & \text{if ZP school}
\end{cases}
\]

b) Percent of Trained Teachers:

Again, let T denotes the percentage of trained teachers. The percentage of trained teachers was segregated in two parts:

(i) Schools having percentage of teachers less than or equal to 98% and
(ii) Schools having percentage of teachers more than 98%.

The dummy variables of percentage of trained teachers were created as follows:

\[T_0 = (0, 0) \text{ if percent of trained teachers is less than or equal to 98%}\]
\[T_1 = (1, 0) \text{ if percent of trained teachers was more than 98%}\]

c) Class Size

Let C denote the class size. The entire range of the class size has been partitioned in three categories as under:

\[C_0: \text{ if number of students > 50, (reference category)};\]
\[C_1: \text{ if number of students are between 40-50};\]
\[C_2: \text{ if number of students < 40};\]
The three category of class size have 2 (i.e. 3-1) dummy variables which have been created as follows:

\[
(C_1, C_2) = \begin{cases} 
C_0 = (0, 0) & \text{if number of students} > 50 \\
C_1 = (1, 0) & \text{if number of students} \text{ between } 40 - 50 \\
C_2 = (0, 1) & \text{if number of students} < 40
\end{cases}
\]

d) **Student-teacher Ratio (STR):**

The entire array of student-teacher ratio was divided into two categories namely:

- **STR\(_0\):** students-teacher ratio was less than or equal to 50 (reference category), and
- **STR\(_1\):** students-teacher ratio was more than 50.

The dummy variable of student-teacher ratio has been defined as

- **STR\(_0\):** \((0, 0)\) if student-teacher ratio was less than or equal to 50
- **STR\(_1\):** \((1, 0)\) if student-teacher ratio was greater than 50

The variables namely type of school management, trained teachers, class size and student-teacher ratio were categorical and used as predictors in the model where quality of primary education has been taken as a dependent variable. Firstly, the interaction between the variables was checked. The process of detection and treatment of interaction factor (if found statistically significant) was given below.

5.3.3 **Interaction**

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What is interaction?

Interaction between two predictors S and C means that the effect of S on the dependent variable Q depends on the level of C, and the effect of C on Q depends on the level of S.
Let us consider a simple model with quality of education (Q) as the response variable and type of school management (S) and Class size (C) as predictor variables. Before applying MCA, it is necessary to first examine whether there was any statistically significant interaction between two predictors or not. If interaction(s) is/are found statistically significant, than it is essential to include interaction term(s) in the MCA model, as another predictor in the model affecting the dependent variable.

5.3.4 Some Theoretical Consideration

Model Specification and Estimation

The usual way of specifying interaction between S and C was to add a multiplicative SC term to the model:

\[
\hat{Q} = a + bS + cC + dSC 
\]  

(3a)

The pair wise relationships were examined among the predictor variables. Although this is the usual specification of interaction, if we don’t know the precise mathematical form of the interaction, choose a simple if it is possible. This approach is in keeping with a general goal of modeling which is to simplify reality down to its essentials so that we may more easily comprehend it.

In estimating the model (3a), SC is considered as if it were a third predictor variable, which is denoted by W. Thus W = SC. The usual way of specifying the interactions between two predictors is to add multiplicative term to model. Then the model is

\[
\hat{Q} = a + bS + cC + dW 
\]

What is the effect on Q of increasing S by one unit? Denoting the new value Q by \( \hat{Q}^* \), the equation (3.1) can be written as

\[
\hat{Q}^* = a + b(S + 1) + cC + d(S + 1)C \\
= a + bS + b + cC + dSC + dC \\
= \hat{Q} + (b + dC) 
\]  

(3b)
The software package namely Statistical Package for Social Sciences (SPSS) examines the interaction and consider the phenomena in terms of an additive model. The complete procedure is firstly to determine a set of suspected interacting predictors. Secondly, it forms single "combination variable" using these predictors, recode the variables and performs MCA analysis. Thereafter it perform one MCA analysis with the "combination variable" as the control in a one-way analysis of variance to get adjusted eta squared, which will be greater than or equal to adjusted R square. Then it use the difference, adjusted eta square-adjusted R square (the fraction of variance explained which is lost due to the assumption of additive model), as a guide to determine whether the use of a combination variable in place of the original predictors is justified.

The test for interaction is based on the same sample as the normal MCA execution. If interactions are detected, then the combination variable is used as predictor variable in place of the individual interacting variables.

5.3.5 Procedure of Estimating Unadjusted Values and Adjusted Values

a) Unadjusted Values

Bivariate Model

The formulae of calculating unadjusted values of quality of education for categories of predictor variables are given in unadjusted quality of education column of Table 5.2. The three cell entries for education are derived from the regression of quality of education on type of school management as:

\[
\hat{Q} = a' + b'S_1 + c'S_2
\]  

(3.1)

The two cell entry is derived from the regression of quality of education on trained teacher as:

\[
\hat{Q} = a'' + d'T
\]  

(3.2)

The three cell entries for class size are derived from regression of quality of education on class size as:
\[ \hat{Q} = a^{**} + e^{***} C_1 + f^{**} C_2 \]  \hfill (3.3)

The two cell entries for student-teacher ratio (STR) are derived from regression of quality of education on student-teacher ratio as

\[ \hat{Q} = a^{****} + g^{**} \text{STR} \]  \hfill (3.4)

The reasons for primes, double primes, triple primes and quadrate primes and letters chosen to denote coefficients have to do with parallel notation for the underlying regression for the adjusted effects, as given below. From these four equations, formulae for computing unadjusted values of quality of education for categories of the predictor variables are derived by setting the predictor variables to appropriate combinations on ones and zeros. For example, the formulae for unadjusted values of quality of education for type of school management in Table 5.2 was obtained by setting \((S_1, S_2)\) alternatively to \((0,0), (1,0)\) and \((0,1)\) in equation (3.1). The formulae for percentage of trained teachers were obtained by setting \(T\) alternatively to 1 and 0 in equation (3.2). The formulae for category of class size was obtained by setting \((C_1, C_2)\) alternatively to \((1,0)\) and \((0,1)\) in equation (3.3). Similarly the formulae for student - teacher ratio was obtained by setting \(\text{STR}\) alternatively to 1 and 0 in equation (3.4).

Alternatively but equivalently, one may derive unadjusted value of quality of education for categories of predictor variables by computing mean of quality of education for each category. For example, if one computes the mean score of academic achievement of \(S_1\) school, the result is identical to the obtained from formula \(a` + b`\). If one computes mean score of academic achievement of \(T\) (proportion of trained teachers > 98%), the result is identical to that computed from formulae \(a` + d`\). It is easy to see why this equivalence exists. In (3.2), for example, the regression line must pass through the mean of \(Q\) values at \(T=0\), and through the mean of values at \(T=1\). But the mean of \(Q\) values at \(T=0\) is simply mean score of academic achievement of students for schools having trained teachers less than equal to 98 percent and \(T=1\) is simply mean score of academic achievement for schools having trained teachers greater than 98 percent. Similarly, in equation (3.1) the regression plane must pass through the means of \(Q\) values at \(S_1 = 0\) and \(S_1 = 1\) when \(S_2\) is held constant, and through the means of the \(Q\) values at \(S_2 =0\) and \(S_2 =1\) when \(S_1\) is held constant.
Because this alternative approach to calculating values of quality of education is simple as compare to regression (3.1) – (3.3). The reasons are firstly there is need for regressions to interpret the measure of goodness of fit, R, and secondly the regressions are useful for understanding the logic of the comparison between unadjusted and adjusted values.

Table 5.2 Set-up for MCA Table of the Effects of Type of School Management, Trained Teachers, Class Size and Student -Teacher Ratio on Quality of Education of Schools

<table>
<thead>
<tr>
<th>Predictor variable</th>
<th>N</th>
<th>Unadjusted</th>
<th>Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of education of schools</td>
<td>R(η)</td>
<td>Quality of education of schools</td>
<td>R (β)</td>
</tr>
<tr>
<td>Type of School Management</td>
<td></td>
<td>R_QS1S2</td>
<td>R_QS1S2.C1C2STR</td>
</tr>
<tr>
<td>S_0</td>
<td>N_00</td>
<td>a'</td>
<td>a + d T + e C1 + f C2 + g ST R</td>
</tr>
<tr>
<td>S_1</td>
<td>N_11</td>
<td>a' + b'</td>
<td>a + b + d T + e C1 + f C2 + g ST R</td>
</tr>
<tr>
<td>S_2</td>
<td>N_22</td>
<td>a' + c'</td>
<td>a + c + d T + e C1 + f C2 + g ST R</td>
</tr>
<tr>
<td>Trained teachers</td>
<td></td>
<td>R_QT</td>
<td>R_QT.S1S2STR</td>
</tr>
<tr>
<td>T_0</td>
<td>N_T0</td>
<td>a'' + d''</td>
<td>a + d + b S_1 + e S_2 + e C1 + f C2 + g ST R</td>
</tr>
<tr>
<td>T_1</td>
<td>N_T1</td>
<td>a''</td>
<td>a + b S_1 + e S_2 + e C1 + f C2 + g ST R</td>
</tr>
<tr>
<td>Class Size</td>
<td></td>
<td>R_QC</td>
<td>R_QC.S1S2T</td>
</tr>
<tr>
<td>C_0</td>
<td>N_C0</td>
<td>a''' + e'''</td>
<td>a + e + b S_1 + e S_2 + d T + g ST R</td>
</tr>
<tr>
<td>C_1</td>
<td>N_C1</td>
<td>a''' + f'''</td>
<td>a + f + b S_1 + e S_2 + d T + g ST R</td>
</tr>
<tr>
<td>C_2</td>
<td>N_C2</td>
<td>a''''</td>
<td>a + b S_1 + e S_2 + d T + g ST R</td>
</tr>
<tr>
<td>Student -Teacher Ratio</td>
<td></td>
<td>R_QSTR</td>
<td>R_QSTR.S1S2C1C2</td>
</tr>
<tr>
<td>STR_0</td>
<td>N_STR0</td>
<td>a'''' + g''''</td>
<td>a + g + b S_1 + e S_2 + d T + e C1 + f C2</td>
</tr>
<tr>
<td>STR_1</td>
<td>N_STR1</td>
<td>a''</td>
<td>a + b S_1 + e S_2 + d T + e C1 + f C2</td>
</tr>
<tr>
<td>R^2 (MCA)</td>
<td></td>
<td></td>
<td>R_QSTR.S1S2C1C2</td>
</tr>
</tbody>
</table>

*The symbols with ‘bar’ are the mean values of the respective variables.

The underlying regressions are:

**Unadjusted:**

Type of school management: \( \hat{Q} = a' + b'S_1 + c'S_2 \)

Trained teacher: \( \hat{Q} = a'' + d''T \)

Class size: \( \hat{Q} = a''' + e'''C_1 + f'''C_2 \)
Student-Teacher Ratio: $\hat{Q} = a + g \cdot STR$

Adjusted:

$\hat{Q} = a + b S_1 + c S_2 + d T + e C_1 + f C_2 + g STR$

Adjusted:

$\hat{Q} = a + b S_1 + c S_2 + d T + e C_1 + f C_2 + g STR$

The unadjusted values for quality of education are given in Table 5.2 are not the same as the unadjusted effects of quality of education of predictor variables. The unadjusted effects of quality of education are computed as differences between the unadjusted values of quality of education for pairs of categories of each predictor variable. For example the effect of $S_1$ on $Q$, relative to $S_0$ is computed as $(a - a') = b'$, which is the coefficient of $S_1$ (3.1). The effect on $Q$ of being high percentage of trained teachers relative to low percentage of trained teachers computed as $(a'' - a') = d''$, which is the coefficient of $T$ in (3.2).

b) Adjusted Values

Full Model

Table 5.2 gives the formulae for calculating adjusted values of quality of education for categories of predictor variables. These are given in the column of adjusted quality of education of schools. These formulae are derived from the underlying regression of quality of education of schools on all the predictor variables i.e. from Full Model:

$\hat{Q} = a + b S_1 + c S_2 + d T + e C_1 + f C_2 + g STR$ \hspace{1cm} (3.5)$

The “adjusted” means “with statistical controls”, that is in the first panel of Table 5.2, which gives quality of education by type of school management, trained teachers, class size and
student-teacher ratio are control variables. In the second panel which gives quality of education by trained teachers, class size, student-teacher ratio and type of school management are control variables. In the third panel, which gives quality of education by class size, student-teacher ratio, type of school management and trained teachers are control variables. In the fourth panel, in which quality of education is regressed on student-teacher ratio, class size, type of school management and trained teachers as control variables. To find the adjusted effect i.e. the net effect of any predictor/factor on quality of education in the model, we control the remaining predictors/factors and covariates taken in the model. Thus, the set of control variables change as we move down to lower panels of Table 5.2.

The formula for computing adjusted values of quality of education for categories of a particular predictor variables are derived from equation (3.5) by setting the predictor variables to appropriate combinations of ones, zeroes and mean values. Statistical controls are introduced by holding the control variable constant at their mean values in the entire sample.

The formulae for adjusted value of quality of education for categories of type of school management in Table 3.1 are obtained by setting \((S_1, S_2)\) alternative to \((0,0)\), \((1,0)\), and \((0,1)\) in the equation

\[
Q = a + bS_1 + cS_2 + eC_1 + fC_2 + gSTR
\]  
(3.6)

The formulae for categories of trained teachers are obtained by setting \(T\) alternatively to 1 and 0 in the equation

\[
Q = a + dT + bS_1 + cS_2 + eC_1 + fC_2 + gSTR
\]  
(3.7)

The formulae for categories of class size are obtained by setting class size \(C\) \((C_1, C_2)\) alternative to \((0,0)\), \((1,0)\), and \((0,1)\) in the equation

\[
Q = a + eC_1 + fC_2 + bS_1 + cS_2 + dT + gSTR
\]  
(3.8)

The formulae for categories of student-teacher ratio are obtained by setting STR alternatively to 1 and 0 in the equation

\[
Q = a + gSTR + bS_1 + cS_2 + eC_1 + fC_2 + dT
\]  
(3.9)
Equations (3.9) – (3.6) are derived from equation (3.5) by setting whichever variables are the control variables to their mean value in the entire sample. The adjusted value of quality of education for reference category type of school management ($S_0 =$ private school) is

$$ a + d\bar{T} + e\bar{C}_1 + f\bar{C}_2 + g\bar{STR} $$

Similarly adjusted value of quality of education for trained teachers is

$$ a + bS_1 + c\bar{S}_2 + e\bar{C}_1 + t\bar{C}_2 + g\bar{STR} $$

The adjusted value of quality of education for reference category of class size ($C_0$) is

$$ a + b\bar{S}_1 + c\bar{S}_2 + d\bar{T} + g\bar{STR} $$

The adjusted value of quality of education for reference category of student-teacher ratio (STR$_0$) is

$$ a + b\bar{S}_1 + c\bar{S}_2 + e\bar{C}_1 + f\bar{C}_2 + d\bar{T} $$

The intercept a by itself is simply the predicted value of quality of education for all predictor variables equal zero.

Adjusted effects of quality of education are computed as differences between adjusted values of quality of education. For example the adjusted effect of quality of education relative to $S_0$, is computed as

$$ (a + b + d\bar{T} + e\bar{C}_1 + f\bar{C}_2 + g\bar{STR}) - (a + d\bar{T} + e\bar{C}_1 + f\bar{C}_2 + g\bar{STR}) = b $$

The adjusted effect of quality of education on high proportion of trained teachers relative to low proportion of trained teacher, is computed as

$$ (a + d + b\bar{S}_1 + c\bar{S}_2 + e\bar{C}_1 + f\bar{C}_2 + d\bar{T}) - (a + b\bar{S}_1 + c\bar{S}_2 + e\bar{C}_1 + f\bar{C}_2) = d $$

Again, in the same way the adjusted effect of quality of education on higher class size relative to low class size is computed as

$$ (a + b\bar{S}_1 + c\bar{S}_2 + d\bar{T} + g\bar{STR}) - (a + e + b\bar{S}_1 + c\bar{S}_2 + d\bar{T} + g\bar{STR}) = e $$
and the effect of adjusted quality of education on higher student-teacher ratio size relative to low student-teacher ratio is calculated as

\[(a + b\bar{S}_1 + \bar{S}_2 + d\bar{T} + e\bar{C}_1 + f\bar{C}_2) - (a + g + b\bar{S}_1 + \bar{S}_2 + d\bar{T} + e\bar{C}_1 + f\bar{C}_2) = g\]

Although controls are normally introduced by holding the control variable constant at their mean values in the entire sample, of values can also be used. For example, consider again the effect of quality of education on type of school \(S_1\) relative to \(S_0\). By holding \(T\) and constant at \(\bar{T}, \bar{C}, \overline{STR}\) and the terms in \(\bar{T}, \bar{C}\) and \(\overline{STR}\) cancel out when computed the difference

\[(a + b + d\bar{T} + e\bar{C}_1 + f\bar{C}_2 + g\overline{STR}) - (a + d\bar{T} + e\bar{C}_1 + f\bar{C}_2 + g\overline{STR}) = b\]

Because of the cancellation, it doesn’t matter how one interpret \(\bar{T}, \bar{C}\) and \(\overline{STR}\); any value will do in the sense that difference will still be \(b\). For example, under some circumstances, we might want to reinterpret \(\bar{T}, \bar{C}, \overline{STR}\) as mean value of \(T, C\) and \(STR\) for student-teacher ratio \((\overline{STR}_0)\) instead of entire sample. The reinterpretation of \(\bar{T}, \bar{C}\) and \(\overline{STR}\) affects the level of the adjusted values of quality of education but not the adjusted effects of quality of education, as measures by pair wise differences between the adjusted values of quality of education.

The MCA mainly assesses the effects, which are measured by differences between values of quality of education and therefore unaffected by how one sets the levels of the control variables. We normally set control variables by their mean values in the entire sample.

Unadjusted and Adjusted 𝑅

Table 3.1 also indicates unadjusted values of the multiple correlation coefficients, \(R\). The unadjusted values of coefficient \(R\) are simply the values of \(R\) for equations (3.1) to (3.4). The adjusted values of \(R\) are computed as partial correlation coefficient \(R\), where the control variables are \(S_1, S_2, C_1, C_2\) and \(STR\) in case of type of school management; \(T, S_1, S_2\) and \(STR\) in case of trained teachers; \(C_1, C_2, S_1, S_2\) and \(T\) in case of class size and \(STR\), \(S_1, S_2\) and \(C_1, C_2\) in case of student-teacher ratio.

Consider for example, \(R_{QS1S2,C1C2STR}\) at the top of the rightmost column of Table 3.1. To calculate this partial \(R\), we first regress \(Q, S_1, S_2\) and \(C_1, C_2\) on control variables, which for this panel of table are \(C_1, C_2\) and \(STR\):
\[
\hat{Q} = h + iC_1 + jC_2 + m \text{STR} \quad (3.10)
\]
\[
\hat{Q} = k + pC_1 + qC_2 + n \text{STR} \quad (3.11)
\]
\[
\hat{Q} = r + sC_1 + tC_2 + u \text{STR} \quad (3.12)
\]

We then form the variables:
\[
Q' = Q \cdot \hat{Q} \quad (3.13)
\]
\[
S_1' = S_1 - \hat{S}_1 \quad (3.14)
\]
\[
S_2' = S_2 - \hat{S}_2 \quad (3.15)
\]

Then we estimate the regression equation
\[
\hat{Q} = u + vS_2' + wS_1' \quad (3.16)
\]

The multiple R for the equation is \( R_{QS1S2C1C2STR} \).

When the main predictor variable is represented by single dummy variable, partial R is same as r, except that R is always considered positive. In basic MCA, R is used instead of small r for the following reason:

When the value of the predictor variable represents categories, as in case of basic MCA, it does not make sense to consider the correlation as a signed quantity, because sign depends on which category is chosen as reference category, which is arbitrary. Because correlations are always considered positive in basic MCA, R is used throughout in Table 5.2.

5.3.6 Application of the MCA Model

The findings of MCA were given in Table 5.3. The notation used in Table 5.3 for unadjusted and adjusted multiple correlation coefficient, namely R, was not the notation conventionally used in MCA analyses. Conventionally \( \eta \) (eta) was used in place of unadjusted R, and \( \beta \) (beta) was used in place of adjusted (i.e. partial). These notations were used in Table 5.3. We had examined the statistical significance between the two predictors using Analysis of Variance (ANOVA). None of the interaction between the selected predictors was found statistically significant. So it was not necessary to include any interaction term in the MCA model.
5.3.7 Results

Table 5.3 presents the results of multiple classification analysis among the four factors namely type of school management, trained teachers, class size and student-teacher ratio. The results were generated by the MCA program in SPSS. The results were obtained by substituting appropriate combinations of ones and zeros and mean values of \( S_1, S_2, C_1, C_2, T \) and STR in the regression equations.

Table 5.3  MCA table of the effect of type of school management, class size, trained teachers and students- teacher ratio on quality of education of schools

<table>
<thead>
<tr>
<th>Predictor variable</th>
<th>N</th>
<th>Unadjusted</th>
<th>Adjusted for factors and covariates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Quality of education of schools</td>
<td>Eta(( \eta ))</td>
</tr>
<tr>
<td><strong>Type of school management</strong></td>
<td></td>
<td><strong>0.77</strong></td>
<td>0.75</td>
</tr>
<tr>
<td>( S_0 )</td>
<td>24</td>
<td>87.91</td>
<td>90.16</td>
</tr>
<tr>
<td>( S_1 )</td>
<td>14</td>
<td>70.11</td>
<td>64.65</td>
</tr>
<tr>
<td>( S_2 )</td>
<td>17</td>
<td>75.81</td>
<td>94.44</td>
</tr>
<tr>
<td><strong>Trained Teachers</strong></td>
<td></td>
<td><strong>0.11</strong></td>
<td><strong>0.06</strong></td>
</tr>
<tr>
<td>( T_0 )</td>
<td>24</td>
<td>80.70</td>
<td>82.68</td>
</tr>
<tr>
<td>( T_1 )</td>
<td>18</td>
<td>88.79</td>
<td>82.84</td>
</tr>
<tr>
<td><strong>Class Size</strong></td>
<td></td>
<td><strong>0.52</strong></td>
<td>0.47</td>
</tr>
<tr>
<td>( C_0 )</td>
<td>24</td>
<td>75.59</td>
<td>82.82</td>
</tr>
<tr>
<td>( C_1 )</td>
<td>7</td>
<td>78.81</td>
<td>80.84</td>
</tr>
<tr>
<td>( C_2 )</td>
<td>12</td>
<td>89.84</td>
<td>82.62</td>
</tr>
<tr>
<td><strong>Student Teacher Ratio</strong></td>
<td></td>
<td><strong>0.79</strong></td>
<td>0.62</td>
</tr>
<tr>
<td>( STR_0 )</td>
<td>24</td>
<td>89.18</td>
<td>84.11</td>
</tr>
<tr>
<td>( STR_1 )</td>
<td>15</td>
<td>71.95</td>
<td>80.40</td>
</tr>
<tr>
<td>( R^2 ) (ANOVA)</td>
<td></td>
<td><strong>0.88</strong></td>
<td><strong>0.84</strong></td>
</tr>
<tr>
<td>( R^2 ) (MCA)</td>
<td></td>
<td><strong>0.89</strong></td>
<td><strong>0.87</strong></td>
</tr>
</tbody>
</table>

** Statistically significant at p<0.001

The type of school management has evidently came out as a dominant variable affecting the quality of education (performance of students). The next variable which had affected the quality of education was student-teacher ratio after controlling the remaining predictors and covariates in
the model. The class size appeared as another significant predictor in determining the quality of education. However, percentage of trained teachers had little effect on quality of education. Trained teachers could be the contributory factor in the quality of education in terms of performance of school. The results indicate that there was less effect in case trained teachers as compared to other variables/factors.

The variable with maximum explanatory power was the type of school management which explained 75% of variability after adjusting the effects of the remaining factors and selected covariates. The analysis showed that the amount of variance explained by 4 variables considered in the analysis of variance was 87%. The finding revealed that 3 out of 4 factors contributed significantly to explain the variability in quality of education of schools; the results were found in expected direction.

5.3.8 Discussion

The findings demonstrated that there was effect of student-teacher ratio, type of School management, class size on quality of school education. The performance of ZP schools was better than private and NMMC schools. All the four variables in an analysis of variance accounted for 87 percent of overall variance in quality of school education. The student-teacher ratio was lower in ZP schools and higher in private and NMMC schools respectively. The factor wise effect on quality of education was discussed below.

Type of School Management

The three types of school management cater the needs of primary school going children in Navi Mumbai. All the ZP schools which were located in Navi Mumbai belong to Raigadh district of Maharashtra; whereas, NMMC schools of Navi Mumbai are situated in Thane district. There are considerable differences in both Thane and Raigadh districts. Due to this, the public schools in this study were divided into two types of schools, namely, ZP schools and NMMC schools. Private schools of Navi Mumbai were located in both the districts. The result showed that type of school management was a salient governing factor which had significant effect on quality of education in primary schools. The performance of ZP schools was better than NMMC and private schools.
It seems that ZP school management may have more effective administration as compared to other school managements. The source of finance was not dependent on fees, it was funded by government. The requirement of teachers, and teacher’s development policy, work load of teachers may be the priority in these schools. There was a cooperation and inspection from management to get desired performance. School management was accountable about responsibilities of principal, school services and resources, student-teacher relationship, class size and professional development of teachers. Therefore performance of ZP school may be better than other school.

Thus our study supported the findings of other researchers that student-teacher ratio influence the performance of students (see Ikediashi and Amaechi, 2012; Mahmood and Khatoon, 2011). The findings had clearly brought out that the students’ performance had strong bearing on type of school management.

According to Tennessee's STAR (Student-teacher Achievement Ratio) Study in 2007, class size and pupil teacher ratio are not the same and that arguments using these two terms as synonyms are flawed. Class size is the number of children in a teacher’s room daily for whom the teacher is accountable; while the pupil-teacher ratio is generated by dividing the number of pupils in one school by all educators, including administrators. Thus, the terminology used by the author was not in conformity with that of the present study. The results were therefore, not comparable.

**Student-teacher Ratio**

The results proved that the schools having lower student-teacher ratio performed better as compared to the performance of schools which had higher student-teacher ratio. Low student-teacher ratio benefits students in many ways. Students may get more chance for one to one discussion with teacher. The teacher gets to know the individual student better which allows them to identify the areas where student needs help, also better and frequent one-to-one communication between teacher and student. This may probably keep the students more attentive and encourage them to be more interactive in the class. Teacher may give individual attention to each student if he/she finds that the students are receptive and had a good grasp of the subject. As found in the present study, ZP schools had better school performance as compared to that of
NMMC and Private schools despite the fact that ZP schools lacked in infrastructural facilities in comparison to other two types of schools. The MCA clearly identified the student-teacher ratio to be the dominant factor responsible for students’ performance in final examination. The reason for lower student-teacher ratio in ZP schools in Navi Mumbai was due to the fact that during last two to three decades the growth of private schools was quite high (32%) in Navi Mumbai (CIDCO 2010). These schools made efforts to provide more infrastructure facilities like sports, indoor games and gymnasium etc. which attracted the parents of children of a section of the society to send their wards to these schools. Thus, mushrooming of Private schools in almost all the parts of Navi Mumbai might have retarded the growth of school children in ZP schools over the years. This development might have resulted in lowering the student-teacher ratio in ZP schools. Another factor which might have further lowered the student-teacher ratio in ZP schools was the mass recruitments of new teachers in ZP schools in recent years. In fact, the Government has provided additional teaching posts in public schools during last few years. The average student-teacher ratio in ZP: NMMC: Private schools was 31:64:46 respectively. The higher student-teacher ratio in NMMC schools was due to population migration. During the last decade the population in NMMC area had increased from 0.7 million (Census 2001) to 1.1 million (Census 2011) including urban slum population. Average age of the population in the city was 29 years which resulted in the youth bulge of migrants in Navi Mumbai. The numbers of NMMC schools had not increased in comparison to population growth.

Class Size

The results of Multiple Classification Analysis further revealed that ‘class size’ of primary school had significantly influenced on the quality of education. Smaller classes are often perceived as allowing teachers to focus more on the needs of individual students and reducing the class time they wasted during the period of disturbance or interference, if any. Smaller class sizes may also influence parents’ choice when they choose schools for their children. During the past few decades, the measures of reducing the class size are prioritized in the educational policies of different countries to improve the quality of educational outcomes (Bascia & Fredua-Kwarteng, 2008).
The average class size of in ZP, NMMC and Private Schools was 27, 58 and 44, respectively. During the data collection, researcher had found some interesting explanation given by teachers and parents that a large section of the society preferred to send their ward to English medium school. All the public schools in Navi Mumbai had Marathi (local language) medium of instruction. Therefore, parents who could afford the fees of private schools preferred to send their child in private schools. All the land owners\(^5\) (villagers) who had better economic conditions shifted their children from ZP school to private school. This could be another reason for lower class size in ZP schools. The main factor behind large class size in NMMC schools was population growth and expanded access to education. The shortage of schools could be reason for larger class size and this could have hampered the quality of education.

However, the effects of differences in class size upon students’ performance are mixed (OECD 2009, 372). Bonesronning (2003) found that the effect of class size was larger in schools with a higher proportion of students from intact families. Woessman and West (2006) have used data of 18 countries and found that estimates of effect of class size on students’ performance are severely biased. In 11 countries, they ruled out large class-size effects.

A number of studies found that there was inverse relationship between average class size and educational outcomes. They found that reducing the class size contributes to minimizing the negative consequences of social inequality, improving students’ achievement, enhancing the basic skills and competencies of students in the first few years of schooling, etc. (Achilles et al., 2002).

A few studies have reported that there was positive impact of reduced class size on student’s achievement. (Gleason, 2012; Kokkeenberg, Dillon, & Christy, 2008; Cuseo, 2007; Fies & Marshall, 2006; Krueger, 2003; Judson & Sawada, 2002).

\(^{5}\)The land is acquired from the 95 villages for development of Navi Mumbai. As a compensation package, 12.5\% share of developed land with 1.5 FSI was returned to land owners/ project affected Person(PAP). They are legally permitted to sale/develop the plot. This has improved the economic conditions of PAPs to great extent.
Trained Teachers

From the multiple classification analysis, it was found that the training of teachers had little effect on the quality of education in primary schools. Proportion of trained teacher had influenced quality of primary education (may not be statistically significant at 5% level of significance) in schools. Majority of teachers of public schools were trained teachers. The private schools had large proportion of untrained teachers compared to public schools. The private schools were relatively new, had comparatively young staff. They may like to change the job due to better pay package. Private schools were lacking in trained teachers, though the teachers in these schools may be more qualified (graduate or post graduate) but with no formal training in education.

Many people teach, some are effective, they maintain students’ interest in subject matter and then a few are truly great they have spent much time in learning to be effectively. Effective teaching is bail of bright future whereas ineffective depress the environment Teachers take help of different methods for their proper working. These methods are pattern of teacher behaviour that recurrent, applicable to various subject matter, characteristics of more than one teacher and relevant to learning (Farooq etal. 2005).

Our results are in line with the findings of Shahid and Shahzadi, 2006; Angrist, Lavy, 2001.

To sum up, it was found that type of school management, student-teacher ratio and average class size affected the quality of education. It has been also observed that students- teacher ratio and class size were low in ZP schools than that of other schools. The performance of students was better in ZP public schools. Nevertheless, despite better infrastructure and physical facilities in private schools, the final examination results were far more impressive in ZP public schools.