Chapter Two

VARIABLES, MEASUREMENT AND METHODOLOGY

The present chapter deals with the conceptualisation and measurement of the variables along with the methodological aspects of the study. In the first section, conceptual clarification of each variable is presented and the methods adopted for assessing each of them are explained. The relevance and theoretical rationale for the inclusion of each of the variables are also given. In the last part of that section, a summary chart is given for ready reference in which the nature and methods of assessment of the variables are presented. The second section deals with a detailed consideration of the methodology - the sample, data collection and statistical analysis.

2.1 : Conceptualisation and Measurement of Variables

In this section, details of the dependent variable are presented first. Thereafter each set of independent variables - student factors, instructional factors, teacher factors, class factors and school factors - is described. Finally, a summary chart of these variables is given.

2.1.1 : Dependent Variables

As is evident from the title of the study, 'learning intellectual skill' is the broad dependent variable. The

term 'intellectual skill' is taken from the theory of Robert.M.Gagne. According to him, there are five categories of learning outcomes: (1) intellectual skills, (2) cognitive strategies, (3) verbal information, (4) motor skills, and (5) attitudes. These five categories represent what is learned. Each of these categories of outcomes requires different types of conditions for learning and retention to occur (Gagne, 1985).

The category of 'intellectual skills' represents those capabilities that make symbol use possible. An individual may learn to interact with the environment by using symbols. Reading, writing, and using numbers are basic kinds of symbol use learned in early grades. As school learning continues, symbols are used in more complex ways: for distinguishing, combining, tabulating, classifying, analysing, and quantifying objects, events, and even other symbols. The term ' intellectual skill' applies to those capabilities which can be considered as 'procedural knowledge'. Discriminations, concepts and rules are the major sub-categories of intellectual skills.

It is theorised that each type of learning outcome necessitates a separate set of conditions. Researchers usually analyse either academic achievement or specific subject matter achievements; but they rarely attempt to

study the factors of a particular type of learning outcome. In the present study, factors and predictors of learning intellectual skill are analysed. As mathematics, because of the nature of the subject itself, consists mostly of intellectual skills, achievement in mathematics forms the focus of the study. It has to be noticed that mathematics learning is treated in the study as an example or representative sample of learning intellectual skills and not as a specific subject matter achievement.

The next decision that has to be made about the dependent variable is regarding the level of education. Because of the following reasons, it has been decided to study tenth class mathematics achievement: First, tenth class is the transitory period for most of the students. Many students stop studying after tenth class. In Kerala, school education ends at tenth class. Thereafter, education is attached to University. Because of these facts, there is a high social value attached to the achievement in tenth class. Second, throughout the school education, it is only in tenth class, a public examination is carried out. So, schools and teachers are relatively more serious in that class. Public opinion about a school is generally formed in relation to its performance in the S.S.L.C. public examination. As such, students study to their optimal level at this stage. Third, the results of tenth class students can be interpreted as the end result of schooling. So, the

specific dependent variable of the study is tenth standard mathematics achievement.

The dependent variable was assessed by the marks obtained by the students in the S.S.L.C. public examination, 1990 (The examination conducted by the Board of Public Examinations, Kerala State for tenth class students). There were two tests in mathematics, each carrying 50 marks. Marks of both the papers were added for each student to obtain an index of mathematics achievement. Hence, the minimum and maximum scores of the dependent variable are zero and hundred.

The details of the independent variables are presented in the following sections.

2.1.2 : Independent Variables

The basic approach of the investigator in the selection of the independent variables was as follows: First, variables were identified by considering their theoretical influence on student learning without specific consideration of the type of learning outcome. Second, variables thus identified were operationalised in relation to the specific type of learning outcome, i.e., intellectual skill. The procedures of operationlisation and assessment were made relevant to the particular level of schooling: secondary stage.

The factors of school learning can broadly be organised into seven : student factors, instructional factors, teacher factors, class factors, school factors, home factors and extra facilities. In the study, the last two sets of factors are clubbed with student factors. Through review of literature and logical analysis, 35 independent variables were selected in the study. The conceptual clarifications together with the aspects of measurement of these variables are presented in the following sections.

2.1.2.1: Student Factors

It is logical that personal factors of individual learners exert a strong influence on school learning. Though a host of variables have been considered by researchers under the personal factor, the present study considers only the cognitive and affective entry characteristics of students. Theoretically, they, together with the factors of instruction, are the most important proximate factors of achievement.

In this category of student factors, eight variables are included. They are:

1. Five variables of entry characteristics

    (Two cognitive and three affective)

2.   One home variable - SES

3.   Two variables of extra facilities.

Each of these variables is explained separately in the following subsections.

2.1.2.1.1: Cognitive Entry Characteristics (CEC)

School learning tasks typically represent some developmental sequences in which later tasks assume some prior learning. This is especially true in sequential sets of learning tasks such as those frequently found in mathematics or science. If learners lack the essential prerequisites for a learning task, it is theoretically impossible for them to adequately learn the task. Even if teaching is manifestly competent, it does not necessarily lead to learning if the students are cognitively unprepared. So, it is hypothesised that many students fail to achieve good marks in tenth class mathematics basically because they lack sufficient mastery of prerequisites.

The variable 'Cognitive Entry Characteristics' (CEC) is defined in the study as the prerequisite types of knowledge, skills, and competencies which are essential for the learning of tenth class mathematics.

In a school learning situation, the essential prerequisites for a learning task include not only the

content-specific prerequisites, but also the ability to comprehend instruction, the ability to keep the information in memory, the ability to accommodate the memorised information appropriately in the existing cognitive structure,etc.. However, in the present study, only the content-specific prerequisites are dealt with.

The level of cognitive entry characteristics was assessed by administering a test during the first two months of the academic year 1989-90. For developing the test, these steps were followed:

1. The content of tenth class mathematics was analysed for listing down the concepts and rules

2. The listed concepts and rules were analysed for identifying the prerequisite concepts and rules

3. A sample of prerequisite concepts and rules was selected to represent the population of prerequisites. Items were designed to test the mastery of each concept and rule. Care was taken to make the items simple and direct. Selected items were given to five experts, including three mathematics teachers, to check the relevance, representation and language. Test was modified according to their recommendations. The final test consisted of 20 multiple-choice questions and 11 short-answer questions. Maximum possible score was 75. There was no time limit. Most of the students

completed the test within 90 minutes. Original test which is in Malayalam and the translated version in English are given in the Appendix.

4. Reliability of the test was established by administering the test to a small group of students (N=40). Re-test reliability with a time interval of two weeks was found to be 0.869.

2.1.2.1.2: Knowledge of Basic Operations in Mathematics (KBOM)

The need of one additional measure of cognitive prerequisites arose from the observation that most of the students in the sample obtained low scores in CEC. In such a situation, the investigator found it necessary to check whether students knew the basic operations. Knowledge of basic operations in mathematics (KBOM) could be treated as a supplement to CEC. KBOM also is an index of cognitive preparedness-but to the most basic level. High score in KBOM is a necessity, but not a sufficient condition for a high score in CEC.

KBOM was assessed by a test conducted during the last term of the academic year 1989-90. Though the assessment was made in the last term, it is treated as an entry characteristic becuse of theoretical reasons.

The test of KBOM consisted of 20 items. Each item was designed to test the mastery of one of the basic operations - addition, subtraction, multiplication and division - with natural numbers, integers, fractions, decimals and variables. All items were of very simple type. Difficult operations - for instance, long division or division with fractions, decimals etc. - were avoided. Each item carried one mark and the total possible score was 20. In order to compute internal consistency, the test was administered to a group of 42 students and the value was found to be 0.891.

2.1.2.1.3 : Affective Characteristics : Academic (ACA)

Motivational variables are regarded as important determinants of student performance. Three affective entry measures are included in the study:

1. Affective Characteristics : Academic

2. Affective Characteristics : Mathematics

3. Academic self-concept.

The general motivation level of students in relation to school learning, at the entry point of tenth class, is termed 'affective characteristics: academic (ACA)'. The following variables are subsumed under the ruberics of this variable: attitudes toward school, teachers and classmates; perception of self ability; readiness to work seriously;

expectations and aspirations; and basic interest in academic activities. This variable was assessed by using a scale developed by the investigator. The preliminary form consisted of 82 items. Only two response categories (Yes/No) were given, considering the nature of tenth class students. The preliminary form was administered to 11 tenth class divisions of three schools. Class teachers and mathematics teachers of each class were requested to list five highly motivated and five least motivated students of the class. Two extreme groups of 30 were formed by including only those students who appeared in both the lists prepared by class teacher and mathematics teacher. Item-analysis was done with these groups and 30 items - which were highly significant - were selected in the final scale. The scale was thus validated by forming two extreme groups for item-analysis by making use of an external criterion - judgements by teachers. The final scale which consisted of 30 Yes/No items was administered to a fresh group of 45 students. The internal consistency was found to be 0.837. The scale in Malayalam and the translated version in English are presented in the Appendix.

2.1.2.1.4: Affective Characteristics: Mathematics (ACM)

Even though the level of motivation of a particular student is high in relation to school learning, he/she may

dislike mathematics. So a specific measure is essential to assess the interest and attitude of students with respect to mathematics learning. Hence the relevance of the variable, 'affective characteristics: Mathematics' (ACM).

'Affective characteristics : Mathematics' is operationalised as the score in the ACM scale. The construction of the scale is described below. First, a preliminary form consisting of 34 statements - half positive and half negative - was developed. For simplicity, only two response categories were given. Preliminary form was administered to six tenth class divisions. Mathematics teachers were requested to list five most interested students and five least interested students in mathematics. Hence, two extreme groups of 30 students were formed. This method was adopted for validating the scale. Through item - analysis, 20 very significant items were slected for the final scale. Internal consistency was found to be 0.9195 in a sample of 40 students. The scores can range from zero to twenty.

2.1.2.1.5 : Academic Self-Concept (ASC)

It is theorised that entry characteristics are the product of prior learning experiences. In relation to the quality of these experiences, learners will gradually develop a generalised self-concept. If the learning history

is characterised by success, the evolved concept of self will be positive. This self-concept has much implications when he/she enters a new learning task.

In the present study, academic self-concept (ASC) in relation to mathematics learning was assessed by a simple procedure. In the 'Personal Data Schedule' one item was included:

'How would you evaluate your performance in
mathematics?'

There were five response choices - low, average, good, very good, and extremely good - and scores range from one to five in the respective order. ASC is operationalised as the score on this five-point scale. This measure represents the generalised perception of students about their success/failure in the learning experiences in mathematics.

Student entry characteristics form the most important cluster of the independent variables. Out of the five entry measures, two are cognitive and the rest, affective. These measures, taken together, assess the initial position of a particular student - his/her cognitive and affective readiness to learn tenth class mathematics. Theoretically, these variables interact with the instructional variables to determine the level of mathematics learning.

2.1.2.1.6 : Socio-Economic Status (SES)

Considering the importance of home in the educational development of the child, researchers have attempted to analyse home environment in terms of structural, attitudinal and process dimensions. The most frequently examined educational environment of the home is that involving structural variables and SES is one of the principal variables in this dimension. The structural variables may not influence educational outcomes directly. Yet, they are correlated with other dimensions of environment and may be seen as exerting an indirect influence.

Socio-economic status is an index of the power and prestige of the family. Psychologists and educationists usually use this variable either as an independent variable or as a control variable. Studies have demonstrated that social class differences are related to a wide variety of variables, including achievement. The assumption is that the higher the position of a family in the hierarchy of SES, the more the chances for the social psychological environment of the home being conducive to achievement.

In a prior study, the investigator developed one SES scale for assessing the social class positions of college students of Kerala state [Calicut Socio-Economic Status Scale - Sasidharan, 1986]. In the scale, five variables are

included: education, occupation, social participation, income, and material possession of the family members. Information is sought about father, mother, elder brothers, uncle and grandfather who are living in the same house with the subject. The scoring procedure is different from other scales. Instead of adding the scores of each person for each variable, only the highest position, by whoever it is occupied, is considered in the scale. For establishing validity, the Calicut scale was administered along with the scale developed by Kuppuswamy to a sample of 109 subjects. The coefficient of correlation was found to be 0.76. The test was found to be highly reliable, as is evident from the re-test reliability of 0.97 with a time interval of two weeks (Unni,1987).

For the purpose of present research, the scale was translated from English to Malayalam. The mode of responses was changed for making it more simple for school children. The categories of uncle and grandfather were removed, but that of elder sisters were added. The re-test reliability with an interval of 3 months was observed to be 0.889 for the present scale. Maximum possible score is 39.

In short, SES was assessed by the translated and modified version of Calicut Socio-Economic Status Scale which was developed by the investigator.

2.1.2.1.7 : Tuition (TN)

Along with the instructional factors of the school, coaching given outside the school should also be given sufficient importance in a meaningful analysis of school learning. Tuition has become the rule of the day than an exception. It has become a craze to such an extent that many of the urban students have started considering school as secondary. Whether tuition differs from school instruction in any qualitative aspects and whether students gain anything special out of it are debatable issues.

In the present study, tuition is included as a dichotomous variable - whether or not a particular student goes for tuition in mathematics.

2.1.2.1.8: Use of Text book and Guide (UTG)

Though a prescribed text book is available for tenth class mathematics, how far students utilise it is an important question. It is a common observation that many students depend wholly on classnotes instead of using text book properly. The students who utilise textbook well are expected to do better in examinations than those who do not attempt it.

Along with the use of text book, another variable that has to be considered is the use of guides. Enough guide books are available and those students who use them have an extra advantage. These two variables are combined together and the variable 'use of text book and guide' is operationalised as follows:

Description	Score
No use of text book or guide	1
Use of guide only	2
Use of text book only	3
Use of both text book and guide	4

More importance is given to text book than guide because the former is the basic book which is essential to be studied. Guides are supportive materials.

The eight variables that are included in the category of 'student factors', are expected to explain much of the variance in student learning. The following sections are devoted to the explanation of other variables, which are associated with school.

2.1.2.2 : Instructional Factors

The variables of instruction pose different kinds of problems for conceptualisation and measurement. Issues

exist about the focus - should we consider teaching as a global entity or split it into components? Instruction is rarely conceptualised and assessed globally in research studies. The major reason for this handicap is that effective teaching is yet not well understood. The theoretical standpoint of the investigator in this issue is outlined below:

1. It should be possible to conceptualise and assess instruction globally and researchers should find ways of materialising this.

2. For making it possible, one essential prerequisite is that of understanding what effective teaching is.

3. As teaching is never effective if student learning does not accompany it, the dimensions of effective teaching should be derived from process-product studies and should be revised timely as our knowledge grows. This stresses the need for empirically-based instructional design theories.

4. Though it is possible to have some general principles for teaching across different levels of education and

across different types of content, attempts have to be made to derive a specific set of principles for a specific type of content to be taught at a particular level of education. Hence, the following sets of principles have to be derived:

a) General principles of teaching

b) Principles of teaching a specific type of content

c) Principles of teaching at each level of education, i.e., elementary, upper primary, secondary,etc.

d) Principles of teaching a specific type of content to students of a specific level.

At present, studies are lacking in many areas listed above. So, more organised studies are needed.

5. Types of content can be conceptualised in many ways. One way, which is preferred by the investigator, is to define types of content in relation to the learning outcome - for instance, the classification of Gagne.

6. Once we derive the principles of effective teaching following the outlines described above, it is possible to define and assess the effectiveness of teaching. Further, these principles should be made an essential component of the curriculum of teacher-training courses.

The above mentioned aspects were considered in the present study for the conceptualisation of quality of instruction in order to assess it globally. Both observation and interview were utilised in the study for the assessment. Observation was meant for assessing the subject- specific and short-term aspects of teaching and interview was meant for assessing the general aspects - both long-term and short-term.

2.1.2.2.1 : Quality of Instruction - Observation (QIO)

In the present study, an attempt was made to derive principles for teaching concepts and rules at the secondary stage of education. The principles were derived from empirical process-product studies of concept learning and rule learning (especially noteworthy were the series of experiments by Tennyson et al in the area of teaching and learning concepts) and the theories and models of school learning, especially from that of Gagne (1985). The set of principles is presented in the Appendix.

Due to lack of sufficient number of studies, deriving principles was comparatively more difficult in the area of teaching rules. Many of the derived principles for teaching rules are not pre-tested because of the non-availability of empirical studies. Another problem is the lack of

sufficient number of studies in which different levels of education are considered. Because of these problems, the given set of principles is not complete in itself. A number of concentrated studies are needed in these areas.

These principles formed the basis for the assessment of instruction through observation. Rather than following a stereotyped behaviouristic orientation, which is in vogue today, the investigator attempted to make the observations interpretative. It does not seem to be logical that quality of teaching can be assessed by simple procedures like counting or timing. Some kind of interpretative judgement is essential.

The focus of the observation was to decide how far the teacher followed the principles in his/her teaching and to rate the instruction using a ten-point scale. The investigator, during each session of observation, made detailed interpretative records in relation to principles. Since it was not possible to make all teachers follow a particular sequence of events involved in teaching the subject, the overall impression based on the detailed record formed the basis of the assessment of instructional quality. Each teacher was observed thrice in the same class. The three observations were spaced in such a manner that the teacher did not remember what he/she did in the earlier

session of observation and that he/she was uninformed when the observation was carried out. This procedure could also minimise any subjective bias that might affect the rating. The final score was the average of the three different ratings.

In the study, the observation was carried out in the second term of the academic year 1989-90. All observations were completed within three months. As it was not at all possible to assess all the 56 classes in the sample, the investigator had limited his observations to only 32 classes. This sub-sample is termed the 'restricted sample'.

2.1.2.2.2: Quality of Instruction - Interview (QII)

Interview was utilised for assessing the general aspects of teaching - both long-term and short-term. The assessment was based on the general principles of teaching which served as interview guidelines. Each teacher was requested to report his/her practices of teaching. The overall picture revealed through these reports was quantified using a five-point scale. The interview was semi-stuctured and semi-formal. All the mathematics teachers of the sample were interviewed during the last term of the academic year 1989-90. Interview schedule is presented in the Appendix.

2.1.2.3 : Teacher Variables

Teacher variables are theoretically more distant to student learning compared with student entry characteristics or instructional variables. The hypothesis is that teacher variables may influence instructional variables and thereby indirectly influence the achievement of students. Along with experience and interest, two perceptual variables regarding the quality of the school are included here.

2.1.2.3.1 : Teacher Experience (TE)

Though there are many contrary evidences, we generally assume that experience makes teaching better. It is not the experience per se which is important; but the qualities that are refined by experience make the difference. Yet, experience is used as a proxy variable in many studies, including the present one.

Teacher experience is operationalised as follows:

Teacher experience	Score
8 years or more	3
4 - 7 years	2
3 years or less	1

2.1.2.3.2: Teacher Interest (TI)

The motivation of teachers is a very decisive factor for effective teaching. If they are dedicated and have a liking for the profession, there are more chances of their teaching being better, other factors being equal. Instead of assessing their temporary interest at the time of data collection, the investigator was interested in assessing their basic interest with respect to the profession. For making an assessment of basic interest, the investigator asked teachers about reasons for selecting teaching as their profession. If the reported reason was interest in teaching, then a score of 2 was given. For all other reasons, a score of 1 was assigned. Thus, teacher interest was assessed in a dichotomous manner.

2.1.2.3.3 : Teacher rated Efficiency of Head Master (EHM)

Each mathematics teacher was requested to rate the efficiency of the head master on a five-point scale. It has to be noted that this variable is treated as a teacher variable and not as a school variable. The perceived efficiency of the HM may have a profound influence on teacher behaviour. Further, impact of HM on students is largely indirect and teachers assume the position of mediators. Becuase of these reasons, the investigator did not attempt the job of averaging subjectivities.

2.1.2.3.4 : Teacher rated Facilities for Teaching
Mathematics (FTM)

For reasons similar to that of the previous variable, facilities for teaching mathematics is treated at the level of the teacher rather than, of the school. Along with the availability of facilities, the adequacy of them as felt by the teacher is also important. Teachers rated the facilities on a three-point scale. So, in a given school, different teachers may rate facilities differently and these differences have been considered important.

2.1.2.4 : Class Variables

A meaningful explanation of student learning has to consider class variables - the nature of other students in the class and the social-psychological environment of the class. A student may become more motivated or less motivated just becuase of his/her exposure to a particular type of class environment. A teacher may adopt a specific style of teaching considering the nature of students in the class.

The class variables that are included in the present study are : attention and participation of students, class

mean CEC, mean KBOM, mean ACA, mean ACM, mean SES, non-absenteeism, and the ratings of teachers with respect to specific variables like ability, motivation, regularity in study, participation and a global rating of the quality of class environment. Each one of these is explained below.

2.1.2.4.1 : Attention and Participation of Students (APS)

During the observations that were made for assessing quality of instruction, classes were rated on a five-point scale for the attention and participation of students. This variable was assessed only for 32 classes (restricted sample) out of 56 classes in the sample. As each class was observed thrice, three different ratings were obtained for APS. The average of these ratings was considered as the score of APS for that class.

2.1.2.4.2: Class ability: Class mean CEC(CEC-C), Class mean KBOM(KBOM-C), and Teacher rated class ability (CA)

Ability is an important dimension of the class. In the study, three measures are used to assess class ability. For the purpose of statistical analysis, class mean CEC was categorised into four levels. Considering the mean and S.D. of class means in CEC, the following system of categorisation was adopted :

Class mean CEC	Categorised score
16 or less	1
17 - 23	2
24 - 29	3
30 or more	4

Similarly, a three-way categorisation was made for class mean KBOM:

Class mean KBOM	Categorised score
8 or less	1
9 - 11	2
12 or more	3

One more measure was used to assess class ability. It was the rating given by mathematics teachers on a three-point scale - above average (3), average (2), and below average (1). Teacher rated class ability has important implications considering the probable influence of it in determining the quality of instruction.

2.1.2.4.3 : Class Motivation: Class mean ACA (ACA-C) Class mean ACM(ACM-C), and Teacher rated class motivation (CM)

The general level of motivation in a class may modify

the existing entry levels of motivation of individual
students. Also, teacher-perceived motivation of the class
may have an impact on quality of instruction. Three
measures of class motivation are used in the study. Both
the variables of class mean ACA and class mean ACM were made
categorised with three levels in the following manner:

Categorised score	Class mean ACA	Class mean ACM
1	19 or less	10 or less
2	20, 21	11, 12
3	22 or more	13 or more

The third measure is the rating of class motivation done by
the mathematics teachers on a three-point scale.

2.1.2.4.4. : Class mean SES (SES-C)

Social class position of the majority of the students
in the class is an important dimension. The following method
of categorisation is adopted for class mean SES.

Class mean SES	Categorised score
6 or less	1
7 - 8	2
9 or more	3

2.1.2.4.5 : Teacher ratings: Study Regularity (SR), Participation (PN), and Quality of Class Environment (QCE)

These teacher ratings have objective and subjective aspects. On the objective side, these measures have direct relevance to student learning. On the subjective side, they may influence quality of instruction. Mathematics teachers were requested to rate the study regularity (SR) and participation (PN) of students each on a three-point scale. Teachers were also requested to rate the overall quality of the class on a five-point scale. They were told to consider the variables of ability, interest, discipline, enthusiasm, study regularity, participation, quality of doubts etc., while giving the global rating.

2.1.2.4.6 : Non-Absenteeism (NA)

Absenteeism has become a disturbing trend in Indian Education. Though school attendance is essential for appearing at the examination, teachers generally are more liberal with regard to this. So, many of the students keep themselves away from the school. Absenteeism and indiscipline appear to be more common in urban schools. Many students, as they go for tuition, consider school as secondary. Tuition is always ahead of school instruction

and schooling becomes boring to those students. Further, if school experiences are not interesting, there is no wonder that students try to avoid them. The question is : does absenteeism affect school learning?

The investigator collected data from students twice in the academic year of 1989-90; first during the first term of the year and the second, during the third term. The percentage of students who were absent each time was calculated for each class. The average of the two was taken as an index of absenteeism. This score was transformed to the score of non-absenteeism by the following method:

Percentaged absenteeism	Categorised score of non-absenteeism
19 or more	1
13 - 18	2
6 - 12	3
5 or less	4

The discussion of class variables being over, next in turn are school variables which form the last cluster of independent variables.

2.1.2.5 : School Variables

Do schools differ from one another and if so, do these variations affect student learning? This question becomes much more prominent when we consider the fact that the students of a school are not a random collection; social origin has an important role in deciding which school a child goes to. It appears that the school a learner attends does have an effect on his/her academic performance. Variations in institutional quality constitute differential context for learning and may result in differential output. The premise is that the quality of the school environment may vary depending on the quality of the existing elements like teachers, students, curricular activities, reward structure, interaction processes and other related factors. The environment can be identified in terms of structural and process dimensions. Nine school variables are included in the study, each of which is explained in the following sections.

2.1.2.5.1 : Student body Characteristics

Five student body characteristics are included in the study : school means of CEC, KBOM, AAC, ATM and SES. All these measures are categorised following the same methods that are used for class means. These measures represent the

averages of ability, motivation and social class of the
school.

2.1.2.5.2 : School Locality (SL) and School Type (ST)

School locality is a dichotomous variable. A school is
considered to be rural, if it is located in a panchayat area
and is considered to be urban, if the location is in a
municipal area. The hypothesis is that the environments of
urban schools may differ from that of rural schools and
these differences may have influences on student learning.

The levels of the dichotomous variable school type are
government and private aided. The study intends to check the
validity of the popular notion that private schools are
comparatively better.

2.1.2.5.3 : Past Achievement of the School (PAS)

In a school with a history of high achievement,
students will be more motivated to study. Students tend to
work hard as they do not want to join the minority group of
failures. School tries to keep up this motivation. As
schools generally take result as their prestige issue, high
achieving ones have to work very seriously for keeping their
position. Schools with average results try either to

achieve more or to continue their present trend. In the present study, past achievement is categorised with three levels as per the following method:

Average percentage of results (1984-85 to 1988-89)	Categorised score of past achievement
Below 30 %	1
30 % - 70 %	2
Above 70 %	3

2.1.2.5.4: Psycho-Social Environment (PSE)

Recent research findings on school effectiveness suggest that the school variables that seem important in affecting scholastic achievement are those that capture the activity (processes) of the school rather than those that reflect status variables. In the present study, the investigator has attempted to make a global assessment of the quality of the school environment. Dimensions of psycho-social environment are derived from empirical studies and theoretical considerations. An environment which is qualitatively high with respect to achievement is one that motivates students academically and offers them needed facilities and social psychological support. It offers reinforcements for good performance. Hence, 'academic demands' is one major dimension. 'Discipline' is another important dimension- discipline of students and that of

teachers. The word 'discipline' is used here in a positive sense by which the values of commitment, seriousness and sincerity are inculcated without curbing natural as well as desirable tendencies. As far as possible, it should not be forced. These two dimensions are derived from different studies, especially that of Coleman et al (1982).

Other than academic demands and discipline, the quality of human relationships also matters. If only the horizontal and vertical relationships are smooth and frictionless, the environment becomes healthy. Along with this, the motivation and sincerity of teachers and headmasters are important dimensions. Further, if the climate is characterised by democratic concerns like shared decision making and enhanced participation, the school will be more prone to academic activities. The role of parents is also important. If the school is sucessful in ensuring the sustained participation and support of parents, the effectiveness of the school will be geared up.

In the study, information was collected on these dimensions by various procedures like an in-depth interview with headmasters, detailed interviews with teachers, informal talks, and personal observations that were made at the time of several visits during the academic year 1989-90. Based on the dimensions, a global assessment was made for

the quality of psycho-social environment of each school. The highest weightage was given to the psycho-social environment thus indexed, if it was found to be highly conducive to achievement, and the lowest weightage was given if it was not at all conducive to achievement. A five-point scale was used for the purpose.

Thus, there are 35 independent variables classified into five sets - student variables, instructional variables, teacher variables, class variables, and school variables. A summary chart of these variables is presented for ready reference.

SUMMARY CHART OF VARIABLES

Variable	Abbreviation	Range
I DEPENDENT		
1. Mathematics Achievement: Student Level	MA	0 - 100
2. Mathematics Achievement: Class Level	MA - C	Categorised:1-8
II INDEPENDENT		
A) Student Variables		
1. Cognitive Entry Characteristics	CEC	0 - 75
2. Knowledge of Basic Operations in Mathematics	KBOM	0 - 20
3. Affective Characteristics : Academic	ACA	0 - 30
		Categorised to 1-4
4. Affective Characteristics : Mathematics	ACM	0 - 20
		Categorised to 1-4
5. Academic Self-Concept	ASC	1 - 5
6. Socio-Economic Status	SES	0 - 39
7. Tuition	TN	Dichotomous
8. Use of Text-book and Guide	UTG	1 - 4

Variable	Abbreviation	Range
B) Instructional Variables		
9. Quality of Instruction: Observation	QIO	1 - 10
10. Quality of Instruction : Interview	QII	1 - 5
C) Teacher Variables		
11. Teacher Experience	TE	1 - 3
12. Teacher Interest	TI	Dichotomous
13. Teacher-rated Efficiency of HM	EHM	1 - 5
14. Teacher-rated Facilities of Teaching Mathematics	FTM	1 - 3
D) Class Variables		
15. Attention and Participation of Students	APS	1 - 5
16. Class mean CEC	CEC-C	1 - 4
17. Class mean KBOM	KBOM-C	1 - 3
18. Teacher-rated Class Ability	CA	1 - 3
19. Class mean ACA	ACA-C	1 - 3
20. Class mean ACM	ACM-C	1 - 3

Variable	Abbreviation	Range
21. Teacher-rated Class Motivation	CM	1 – 3
22. Class mean SES	SES-C	1 – 3
23. Teacher-rated Study Regularity	SR	1 – 3
24. Teacher-rated Participation	PN	1 – 3
25. Teacher-rated Quality of Class Environment	QCM	1 – 5
26. Non-Absenteeism	NA	1 – 4
E) School Variables		
27. School mean CEC	CEC–S	1 – 4
28. School mean KBOM	KBOM–S	1 – 3
29. School mean ACA	ACA–S	1 – 3
30. School mean ACM	ACM–S	1 – 3
31. School mean SES	SES–S	1 – 3
32. School Locality	SL	Dichotomous
33. School Type	ST	Dichotoous
34. Past Achievement of the School	PAS	1 – 3
35. Psycho-Social Environment	PSE	1 – 5

2.2 : METHODOLOGY

In this section of the chapter, methodological details
- population and sample, data collection and methods of
analysis - are presented.

2.2.1 : Population and Sample

The study was carried out in the secondary schools of
Palghat revenue district (Kerala State, India).
Statistically, the direct population of the study is the
tenth class students of Palghat district whose medium of
instruction is Malayalam. There are 130 Secondary Schools
in this revenue district. The revenue district of Palghat
is divided into two educational districts - Palghat and
Ottapalam, each having 85 and 45 secondary schools
respectively. Stratified random sampling technique was
followed for selecting the sample. The sampling unit of
the study was school. That is, from a selected school, all
tenth class students of Malayalam-medium were studied.

Stratification was done based on the educational
district, school locality (Urban / rural), school type
(government / private aided), and sex of students
(single/mixed). From each of the strata, nearly ten percent
of schools were randomly selected. Sampling break-up is
shown in the Table 2.1.

Table 2.1 : Sampling break-up according to the educational district, school locality, school type, and Sex of students (In brackets, no. of schools in the population are given)

PALGHAT REVENUE DISTRICT - 15 (130)

	Palghat Educational District 9 (85)				Ottapalam Educational District 6 (45)			
	Government 5 (34)		Private Aided 4 (51)		Government 2(22)		Private Aided 4 (23)	
	Urban 2(7)	Rural 3 (27)	Urban 0 (5)	Rural 4(46)	Urban 0 (1)	Rural 2 (21)	Urban 2(2)	Rural 2(21)
B-	1(5)	0 (0)	0 (5)	0 (0)	0 (1)	0 (0)	1 (1)	0 (0)
G-	1(2)	0 (2)	0 (0)	0 (1)	0 (0)	0 (0)	1 (1)	0 (1)
M-	0(0)	3(25)	0 (0)	4(45)	0 (0)	2(21)	0 (0)	2(20)

Note : B - Boys; G - Girls; M - Mixed

Thus, a total of fifteen schools were selected from 130 secondary schools of Palghat revenue district. In the population, all urban schools are single and all but four rural schools are mixed. In the sample, urban-single schools were over represented (4/15) compared with rural schools (11/115). From the five tribal schools in the population, one was selected in the sample. The number of tenth class Malayalam-medium divisions was different in the schools of the sample - from one division to six. There was a total of 56 divisions in the sample. The total number of students in the sample was 2432 out of which 591 students were absent in at least one session of data collection. These 591 students were eliminated from the analysis. Hence, the number of students in the effective or final sample was 1841 - consisting of 892 boys and 949 girls.

2.2.2 : Restricted Sample

That part of the sample in which observations were carried out for the assessment of quality of instruction, is termed 'restricted sample'. There were ten schools in the restricted sample. From Ottapalam educational district, all the six schools of the sample were included in the restricted sample also. But from Palghat educational district, only four schools were selected out of nine schools in the sample. The selection was not done in a

random fashion. Hence, the restricted sample may not purely represent the sample. Out of the ten schools, four were government. Two schools were urban-single. The number of students in the restricted sample was 1116 after eliminating those students whose information was incomplete. There were 32 classes in the restricted sample and all these classes were observed thrice for the assessment of quality of instruction.

2.2.3 : Data Collection

Data were collected during the academic year 1989-90 in a phased manner. During the first term of the year (June, July, August), assessment was made for all student variables except KBOM. The test for CEC, the scales for ACA, ACM and SES, and Personal Data Schedule were administered in all the 56 classes during that time. The second term of the academic year (September, October, November) was utilised for assessing quality of instruction through observation. Observations were made only in the restricted sample. Each one of the 32 classes in the restricted sample was observed thrice in a random fashion. During the last term of the year (January, February), the following activities were completed : assessment of KBOM, interviews with head masters and mathematics teachers, and the assessment of school environment. Students gave their public examination in

March, 1990. In June, 1990, the results of the S.S.L.C. examination were announced. The last phase of data collection was the collection of results.

All tests and scales were administered in group-settings. Though students were instructed to work independently, copying could not be ruled out completely. Instructions were given to the whole class and the doubts were clarified, whenever required. Students were completely uninformed about the tests.

2.2.4 : Analysis

Data were analysed using different techniques of statistics including mean, standard deviation, coefficient of correlation,stepwise regression, analysis of variance, and multiple classification analysis. The results are presented in third and fourth chapters. Correlational and descriptive analyses of the variables are given in the third chapter. Several generalisations regarding concept teaching and rule teaching are also presented in the same chapter. Fourth chapter is devoted to the results and interpretations of stepwise regressions, analysis of variance, and the multiple classification analysis.