CHAPTER III

DESIGN OF THE STUDY:

3.0.0 PROLOGUE:

As pointed out earlier the present investigation is related to the expository-discovery controversy. The objectives of the study have been put forth in section 1.6.0. Research studies related to this particular dilemma have been reviewed in Chapter II. The present investigation has been designed taking into consideration the objectives and various implications of the research studies reviewed. The details about design of the study is presented in this chapter.

Kerlinger (1973, p. 300) defined research design as the plan, structure and strategy of investigation so as to obtain answers to questions and to control variances. According to this definition, research design involves two important aspects: (1) selecting the particular type of experimental design, and (2) controlling the various variables involved in the study such that it maximizes the amount of experimental variance, controls the effects of extraneous variables and minimizes the error variance of the study.

Selecting a particular type of experimental design depends upon what type of research questions the investigator wants to answer. There are different kinds of experimental designs which give different kinds of information. If information about the time is wanted, a repeated measurement
design is required. If there is interest in what effects the order of presentation of treatment has, a latin-square design is useful. If the experimenter hypothesizes that the effects of the independent variable are a function of certain characteristics of his subjects, some efforts might be made to match these characteristics. If the experimenter is interested in finding out the simultaneous effects of two or more variables, the factorial designs are preferred.

Therefore, in order to select a particular experimental design and to control the variances the investigator must study the nature of the relationship between different variables involved in the study. The present investigation is related to the study of the comparative effectiveness of the two teaching methods. Shulman (1970, p.63) suggested a model for testing the effectiveness of two or more methods of teaching. With the help of this model one can examine the various variables involved in the study of the effectiveness of two or more methods of teaching. This model helps in formulating any proposition about the best forms of instruction. This model is given in Figure 3.1.

Model of studying effectiveness of teaching methods

Fig. 3.1
1. Type of subject matter:
   Mathematics ....... Social Studies ......

2. Type of instruction:
   Expository-discovery; inductive-deductive ......

3. Amount of instructional type and place in instructional sequence:
   Number of minutes or hours of instruction etc. ......

4. Objectives of instruction:
   Products, processes ....... attitudes etc. ......

5. Entering characteristics of learners:
   Prior knowledge, aptitude, cognitive style ......

Applying this particular model to the expository-discovery controversy the researcher decided to design the study taking into consideration different variables given in the model itself as follows:

   With respect to variables 1 and 3, the type of subject matter and the amount of instruction, the researcher felt the need of undertaking the field study with respect to teaching methods adopted by the teachers of mathematics teaching grade VII. The outline of the field study is given in the Section 3.1.0.

   With respect to variable No. 2 the researcher selected expository and guided discovery methods of teaching mathematics for investigation. While developing the lesson plans of the guided discovery method, the researcher utilized
both inductive as well as deductive discovery methods of teaching mathematics.

Objectives of instruction help both in planning and evaluation of the effects of instruction. Therefore, knowledge, comprehension, and application objectives were taken as criterion variables for studying the effectiveness of these two methods of teaching. Students’ prior knowledge and intelligence are the two most contributing factors towards variance with respect to achievement in many subjects in general and mathematics in particular. The researcher was interested in studying the simultaneous effects of intelligence along with method on the achievement of the students. Therefore, the factorial design was selected as a research design. The details about the design are given in Section 3.2.0.

Lastly, method interacts with the cognitive characteristics of the students, which in turn give rise to variation in interaction patterns of teaching itself. For this reason while designing the study, it was thought necessary to study the variation in teaching method due to change in cognitive characteristics such as intelligence of the students. An outline of analysis of the teaching process is given in Section 3.3.0.

3.1.0 FIELD STUDY:

i) Concept of Field Study:

English H.B. and English A.C. (1962, p.20) interpreted the term field study/investigation as follows:
Collection of the data outside the laboratory, library, or clinic; the study of organisms in their usual habitats.

An inclusive term covering any kind of method from brief interview to carefully controlled experiment. Emphasis is upon the place and not the method.

Kerlinger (1973, p. 405) defined field studies as ex-post facto scientific inquiries aimed at discovering the relations and interactions among sociological, psychological and educational variables in real social structures.

If one analyzes these two interpretations one finds that field studies are closely related to reality. These can be as simple as describing a phenomenon under study and as complex as finding out the interrelationships between different variables. Therefore, the field is very rich in discovering potentialities. Secondly, with the help of field study one can explore several aspects of the situations by using different types of tools of investigation. Even though there are variations in the nature of the field itself, one can find some consistencies in the field. These consistencies should be explored through the field study.

Field studies are useful for bridging the gap between theory and practice. Field studies in teaching can be as simple as describing the teaching phenomena to as complex as establishing the relationship between observed teacher behaviours and their effect on pupils' achievement. Therefore,
the nature of the field study depends upon the purpose of the field study. In the present investigation, the major objective of the field study was to select a unit and to determine number of periods required for that particular unit of teaching from Grade VII mathematics syllabus for the experiment. Therefore, the field study was limited to description of different activities of the teachers with respect to classroom teaching such as teaching methods, aids, number of periods allotted to different topics/units from the syllabus and other co-curricular activities related to teaching of mathematics.

ii) Sample:

The sample comprised 40 mathematics teachers teaching Grade VII. These teachers were selected from both boys and girls schools in Pune city. The total number of schools involved in the study was 15. Selection of the school was made on the basis of deliberate sampling or purposive sampling method. The selected schools were in the neighbourhood of experimental schools where the researcher had planned to undertake the experiment. Since the field study was designed for a specific and a limited purpose, the schools were not selected on a random basis.

iii) Tools used:

A questionnaire consisting of open end as well as, closed end questions was developed by the researcher. It consisted of various aspects of classroom teaching and the teacher such as (i) general information about the teacher,
(ii) information about the classroom size, seating arrangement, (iii) classroom organization, (iv) organization of curricular and cocurricular activities, (v) teaching methods and materials used, (vi) their opinion about course contents and special efforts taken by the teacher to improve the achievement of the students. The developed questionnaire was discussed with teacher educators and also with teachers teaching Grade VII mathematics before finalization. The final version of the questionnaire was administered to teachers selected for the study.

iv) Statistical treatment:

The field study was limited to description of the various aspects of the classroom teaching and therefore, only descriptive statistics such as mean, mode, percentages, range, weighted means etcetera were used for the analysis of the data.

The details about field study are given in Chapter IV.

3.2.0 EXPERIMENT:

i) Planning the Experiment:

Experimental research provides a systematic and logical method for answering the question, "If this is done under carefully controlled conditions, what will happen?" In this type of research, the experimenter manipulates conditions and takes the observation of changes in the environment. Therefore, in planning educational experiments four basic aspects of the experiments as given
by Myers (1979) had to be decided before undertaking the experimental work. These four basic aspects of planning the experiment are given in figure 3.2.

Planning the Experiment
Fig. 3.2

(a) **Independent Variable** :

Independent variable is the factor which is measured, manipulated, or selected by the experimenter to determine its relationship to an observed phenomenon. Independent variable may be qualitative or quantitative. In the present study, expository and guided discovery methods of teaching mathematics were taken as the qualitative independent variables i.e. they differed in quality or type. While dealing with qualitative variables, the difference between
two methods should be pulled apart so as to make them unlike. The researcher developed all the lesson plans based on these two methods so as to make these two methods different from each other.

The second independent variable selected by the researcher was a quantitative one: intelligence of the students. This particular variable was built in the research design itself for the following reasons:

1. There is positive and significant correlation between intelligence and the achievement of the students. This relationship was found in various research studies, such as Rastogi (1964), Sinha (1965), Sinha (1967), Jha (1970), Lalithamma (1975) and others. Lavin (1965) also found that general intelligence tests typically correlate about $+0.50$ ($\pm0.10$) with achievement over a great variety of subjects. Bloom (1976, p.52) found that correlation between arithmetic achievement and intelligence reduced to 0.30 or less, when prior achievement was held constant.

2. Thomas and Snider (1970) while investigating effects of discovery and expository methods of teaching mathematics found that there exists an interaction between treatment and the intelligence of the students. This study is reported in Section 2.2.0. The superiority of learning by discovery for high ability pupils has also been recorded by Herman (1971). The superiority of the ruleg method (expository) for average and low ability subjects was

Hawkins (1966, p.11), writing in the context of the evaluation of discovery learning, suggested that the issue should not be about better or worse ways of teaching. 'The notion that there is a single best way of teaching, across the universe of intellectual differences, of histories of preparation, of age, of teachers, is highly implausible'. In short, the superiority of either expository or discovery method has not been established for all levels of intelligence. In other words, intelligence interacts with the treatment/teaching method. Therefore, this important factor affecting the achievement of the students in mathematics was built-in in the research design itself. These two factors contribute towards the experimental variance.

(b) Control of Extraneous Variables:

The control of extraneous variables means that the influences of independent variables extraneous to the purpose of the study are minimized, nullified or isolated. Prior knowledge of the students, teacher variable, contamination between two experimental treatment groups and home work are some of the factors affecting the achievement of the students. Secondly, these two methods of teaching may have differential effect on boys and girls. This also should be taken into account while controlling the effect of these
extraneous variables. In the present investigation, these variables were controlled and the effect in case of some was minimized in the following way.

**Prior Knowledge:** Mathematics has a hierarchical structure; therefore, studying any concept in mathematics requires some basic knowledge. The relationship between prior achievement and subsequent achievement has been studied by Payne (1963). He demonstrated that arithmetic achievement at grade 6 could be predicted by arithmetic achievement at grade 2, with correlation of approximately +0.70. For achievement on a subsequent related course, the median relation is in the neighbourhood of 0.85. In general, almost 75% of the variation in achievement at the end of a course is predictable from the measures of achievement or protest before the course starts. Bloom (1976, p.46) stated that in the prior achievement-later achievement studies, the correlation averaged about +0.80 between two measures of achievement—even when the effect of overlap between the two measures was reduced. Therefore, pre-achievement is the most contributing factor towards variance in the subsequent achievement of the students. Therefore, it was decided to administer a test to the students, based on previous knowledge required for learning the unit taught during the experiment. These scores on prior knowledge test were treated as covariates. Thus, this factor was statistically controlled by using ANCOVA technique for data analysis.
Teacher Variability: In the present investigation, it was decided to use 'live teacher' for teaching during the experimental treatments. In order to avoid inter-teacher variations, it was planned to involve only one teacher teaching by both the methods.

Sex of the Students: It is likely that these two methods of teaching mathematics have differential effects on achievements of boys and girls. It may be a possible influential variable affecting the achievement. In order to affect homogeneity with respect to this variable, it was decided to select only girls' schools for the experiment. The researcher was aware of the fact that by involving only girl students as subjects for the experiment, the power of generalization was reduced. The researcher did not want to extrapolate the results to boy students also.

Contamination: Contamination between the experimental treatment groups also affects the results of the experiment. It was planned that contamination between the two experimental treatments be avoided by selecting two different schools which are away from each other. Secondly, these two treatments were employed at two different points in time.

Contamination between experimental students and other students from the same school was minimized by giving other teachers teaching mathematics to VII grade, a detailed timetable of the experiment and also lesson plans to be implemented along with class assignment and home work. The teachers were requested to adhere strictly to the time table.
given to them during the experimental sessions and teach other students accordingly not involved in the experiment from the same school.

**Home Work:** Home work also affects the achievement of the students. Therefore, in order to control the effect of this particular variable, the students were given cyclostyled home work sheets on each of the lesson, during the experimental treatments. They were given instructions not to solve examples other than given in home work sheets.

**Minimization of Error Variance:** Error variance is variability of measures due to random fluctuations of the uncontrolled variables. These are self-compensating and unpredictable. Error variance is due to individual differences of students involved in the study and errors of measurement. In the present investigation, individual differences of the students such as intelligence and prior-achievement were controlled experimentally and statistically, respectively. It was assumed that other variables have random effect on the achievement and it was decided to lump variance due to other factors in the error variance at the time of analysis.

Errors of measurement were taken care of by giving uniform instructions to the students at the time of the test; seating arrangement was also such that students could not find chance for copying. Secondly, detailed expectations about the answers to each questions were included in the question paper itself. For uniform assessment of answer scripts of the students, a detailed marking scheme was
prepared by the researcher. All the tests were constructed on the basis of the objectives of teaching the selected unit after developing a blue print of each test constructed.

In this way, the researcher took the care of minimizing the effect of extraneous variables on the achievement of the students.

(c) Selection of the Dependent Variables:

As earlier pointed out in Section 1.9.vii, the present study was limited to achievement of the students in the cognitive domain only. Therefore, achievement of the students in the cognitive domain was taken as a dependent variable. Standardized achievement tests based on the syllabus of grade VII were not available. Therefore, the researcher constructed a test based on the selected unit for the experiment. A test based on previous knowledge essential for learning of the selected unit was also prepared. Both the tests were prepared keeping in view the objectives of teaching the particular unit. Knowledge, comprehension and application objectives were taken into account while constructing the tests. These objectives were underlying the development of the lesson plans and the teaching itself. The scores on test items related to knowledge, comprehension and application objectives and total achievement scores were taken as dependent variables for the analysis of the data. The same test was administered 3 weeks after the conclusion of the experiment to measure the retention of the content taught to the students during the experimental session.
(e) Selection of the Subjects:

Selection of the Grade Level:

Grade VII was chosen for the experiment because, (i) there are a number of units in the syllabus amenable for teaching both by expository and guided discovery; (ii) both the types of guided discovery method: inductive-discovery and deductive-discovery methods can be used with respect to some of the units from the grade VII syllabus, and (iii) guided discovery method can be used with respect to some of the units from the syllabus at the three levels of representation that is enactive level (where the students manipulate the material directly), ikonic level (where the students deal with mental images of the objects but do not manipulate them directly), and symbolic level (where students strictly manipulate symbols and not mental images of objects). Therefore, the researcher decided to select the subjects for the experiment from VII grade students only.

Selection of the Schools:

While selecting the schools for the experiment, the following points were taken into consideration by the researcher:

(i) Only girls' schools were selected for the experiment in order to control variability due to sex of the subjects.

(ii) In the present investigation, it was planned to incorporate built-in intelligence of the student as a factor in the research design. Therefore, in order to get students
from all levels of intelligence, the schools which were having atleast 6 to 7 divisions of the VII grade were contacted through correspondence as well as in person. The total number of schools contacted was four.

(iii) Out of these four schools two schools were selected after discussing the details of the experiment with heads as well as teachers teaching VII grade. The schools which showed willingness to co-operate readily were finally selected by the researcher for the experiment. According to the researcher, this practical consideration in selecting the schools for the experiment is more important than any other criterion.

Selection of the subjects :-

The schools which were selected for the experiment had given permission to the researcher on the condition that the researcher should not disturb the school time table during the conduct of the experiment. As the researcher wanted to implement the factorial design for his study, it was a challenging task for the researcher in selecting the subjects for the experiment. The researcher could meet this task successfully by implementing a systematic procedure for selecting the subjects which is given below.

(i) Test of intelligence was administered to all the students belonging to VII grade from both the schools.

(ii) Percentile ranks of each of the students were found out.
(iii) On the basis of percentile ranks, the students were categorized into three different levels of intelligence—high (percentile ranks P75 or more than P75), middle (percentile ranks between P25 and P75), and low (percentile ranks P25 or less than P25).

(iv) The number of students belonging to each level of intelligence was found out with respect to all the divisions from both the schools.

(v) VII A, VII C and VII D divisions were selected for the experiment from the first school because (a) these divisions as a whole were having sufficient number of students belonging to high, middle and low intelligence respectively, and (b) there was no overlapping of the periods of mathematics in the school time-table. A similar procedure was adopted to select the divisions from the other school also.

(vi) Students of high intelligence were selected from VII A, middle intelligence and low intelligence students from VII C and VII D respectively.

(vii) Then the students belonging to VII A, VII C and VII D from high, middle and low intelligence groups from the first school were matched with those from the second school on a one to one basis, taking into consideration percentile ranks of the students.

Thus two sets of 16 students belonging to each of the three levels of intelligence from three different divisions from each of the two schools were selected for
the experiment. This particular procedure helped the researcher to implement the factorial design without disturbing the time table of the school during the conduct of the experiment. Each of the divisions from which the sets of students were selected for the experiment was having not less than 50 students. But during the experimental period of 9 days, 16 students selected from each of the divisions were taught separately by the experimental teacher and the remaining students were taught by the regular teacher of the school. Thus during the experiment each division was divided into two sections. This resulted in the smooth running of the experiment without disturbing the time table, as per the condition stipulated by the school authorities.

ii) Experimental Design:

Selection of a particular design depends upon the information the investigator wants to explore with respect to a particular problem. In this study, the researcher wanted to study the effects of the treatments as well as interactions between the independent variables selected in the study. Therefore, the researcher selected the factorial design as a basic design for the study. In order to control the effect of prior achievement of the students on post-achievement, the scores on the previous achievement test with respect to different objectives were taken as covariates. Therefore, the design selected for the study can be described as a factorial design with the covariate.
(c) Description of the Design:

Many authors have given definitions of factorial design. Some of these definitions are given below.

Fox (1969, p.476): In any instance when the researcher wants to study the effect of more than one variable and has at least two gradations of each variable, he has an example of what is called as factorial design.

Dayton (1970, p.66): Factorial designs involve the simultaneous application of two or more different treatments within a single experiment.

Tuckman (1972, p.109): Factorial designs are modifications of the true experimental designs with further complications that additional independent variables (usually moderator variable such as intelligence) are included in addition to the treatment variable.

Kerlinger (1973, p.351): Factorial design is the structure of research in which two or more independent variables are juxtaposed in order to study their independent and interactive effects on a dependent variable.

If one analyzes these definitions one finds that in factorial design one can study the effects of two treatments simultaneously as well as their interactive effects on the dependent variables. In the present investigation, methods of teaching and intelligence were taken as two factors. Two levels of methods of the teaching factor and three levels of the intelligence factor were decided upon by the researcher.
In each of the sub-groups there were 16 students. Total students involved in the study were 96. The design is schematically represented in figure 3.3.

### Treatment A

<table>
<thead>
<tr>
<th></th>
<th>Expository</th>
<th>Guided Discovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>Y X</td>
</tr>
<tr>
<td>111</td>
<td>111 121</td>
<td>121</td>
</tr>
<tr>
<td>High Intelligence</td>
<td>X 112</td>
<td>Y 112 122</td>
</tr>
<tr>
<td></td>
<td>. . . . . .</td>
<td>. . . . . .</td>
</tr>
<tr>
<td></td>
<td>. . . . . .</td>
<td>. . . . . .</td>
</tr>
<tr>
<td></td>
<td>X 11n</td>
<td>Y 11n 12n</td>
</tr>
</tbody>
</table>

### Treatment B

<table>
<thead>
<tr>
<th></th>
<th>Expository</th>
<th>Guided Discovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>Y X</td>
</tr>
<tr>
<td>211</td>
<td>211 221</td>
<td>221</td>
</tr>
<tr>
<td>Middle Intelligence</td>
<td>212</td>
<td>Y 212 222</td>
</tr>
<tr>
<td></td>
<td>. . . . . .</td>
<td>. . . . . .</td>
</tr>
<tr>
<td></td>
<td>. . . . . .</td>
<td>. . . . . .</td>
</tr>
<tr>
<td></td>
<td>X 21n</td>
<td>Y 21n 22n</td>
</tr>
</tbody>
</table>

### Low Intelligence

<table>
<thead>
<tr>
<th></th>
<th>Expository</th>
<th>Guided Discovery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>Y X</td>
</tr>
<tr>
<td>311</td>
<td>311 321</td>
<td>321</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>Y X</td>
</tr>
<tr>
<td>312</td>
<td>312 322</td>
<td>322</td>
</tr>
<tr>
<td></td>
<td>. . . . . .</td>
<td>. . . . . .</td>
</tr>
<tr>
<td></td>
<td>. . . . . .</td>
<td>. . . . . .</td>
</tr>
<tr>
<td></td>
<td>X 31n</td>
<td>Y 31n 32n</td>
</tr>
</tbody>
</table>

**Experimental design**

Fig. 3.3
Where,

\[ X : \text{Scores on pre-achievement test.} \]
\[ Y : \text{Scores on post test.} \]
\[ n : 16 \text{ in each subgroup } N = 96. \]

First subscript related to level of intelligence, second to treatment.

\[ X_{11} : \text{Score of first student belonging to high intelligence group taught by expository method.} \]

(iii) Tools for the Experiment:

(i) Raven's Progressive Matrices Test was used to test the intelligence of the students. This test is a general mental ability test which is widely used in many researches. This test was chosen by the researcher because,

(a) It is a test of clear thinking and reasoning, which are essential processes for learning of mathematics;

(b) It is a non-verbal, culture free, group test of intelligence;

(c) The reliability of the test is 0.89;

(d) It is a power test, not having any time limit for completion;

(e) This test is suitable for all age-groups;

(f) Administration and scoring of test are very easy and they do not require trained and expert experimenters.

(ii) Pre-achievement Test: The test based on previous knowledge was prepared by the researcher. This test consisted of multiple choice test items, short answer and essay type
questions covering the content which was essential for the learning of the selected unit. The items were based on knowledge, comprehension and application objectives. The details of the test are given in Section 5.2.0.

(iii) Post Test:– The test based on the content taught during the experiment was prepared by the researcher. The test consisted of multiple-choice test items, short answer and essay type questions covering the content taught. The items were based on knowledge, comprehension and application objectives. The details of the test are given in Section 5.2.0.

The details of the conduct of the experiment are given in Chapter V.

iv) Statistics used for the Analysis of the Data:–

Separate analyses for knowledge, comprehension application and total achievement scores were done. Knowledge scores on post test were adjusted by taking knowledge scores on pre-achievement test as covariate. Similar analyses were done for comprehension, application and total achievement scores by taking the respective scores on pre-achievement as covariates. ANOVA was used for the adjusted scores to fulfil the objectives of the study. 't' test was also used to test the significance of the difference between two means between the two groups. The details about the method of analysis are discussed in Chapter VI.
3.3.0 PROCESS ANALYSIS:

i) Significance of the process analysis:

The most significant short-coming of the research studies reviewed in chapter II was the failure of the investigators to observe classroom activities of teachers with respect to expository-discovery methods of teaching. The question is what are the subtle differences between these two methods. Till this date, this information has not been explored. Gage (1963, p. ) commenting upon the earlier research approaches in the area of teaching, said that these approaches treated the classroom as a 'black-box' into which were fed teachers, pupils, hardware, and software and out of which came various results - and more or less pupil learning. But during the past two decades, investigators have been analysing the teaching process with the help of category systems. But what Gage has commented still applies to the expository-discovery methods of teaching. No analysis of teaching methods at the micro level has been made by investigators. Therefore, the researcher felt the need to analyze the teaching process and to determine the interaction patterns associated with these two methods of teaching mathematics.

Secondly, there are variations in teaching methods due to change in context variables. The relationship between context variables and the teaching process has been studied in natural classroom settings by many investigators. These studies have been reviewed by Dunkin and Biddle (1974).
this relationship with respect to expository-discovery methods was not studied so far by the investigators.

Thirdly, the researcher is of the opinion that whatever the significant-nonsignificant results are obtained with respect to the product of teaching, these differences should be explained in terms of similarities or differences in the teaching process. This necessitates the study of process-product relationship with respect to expository-discovery methods of teaching.

Lastly, investigators should try to develop the effectiveness of the methods not only in terms of product but also in terms of process-variables. This aspect is more important because it may throw some light upon the effectiveness of the method, which needs to be explored.

The process analysis of the teaching in the present study was designed by the researcher taking into consideration the points mentioned above.

ii) Tools used :-

(i) It was decided to record all the lessons given by the teacher during both the experimental treatments on an audiotape. In order to obtain a good quality of recording two powerful microphones which were specially built by the specialists in sound recording were used.

(ii) Lessons contained both verbal and non-verbal activities of both teacher and students. Therefore, in order to supplement the information to be obtained from the
audio-tape, two proformas were developed by the researcher: (a) proforma for chalkboard work, and (b) proforma of time distribution schedule of non-verbal activities. A copy of each of the proformas is given in the appendix.

(iii) For the analysis of interaction patterns associated with the expository-guided discovery methods of teaching mathematics, the expanded system of Flanders Interaction Analysis Category System was used. The observational system for instructional analysis developed by Hough (1965) was selected by the researcher out of 79 systems given in Mirrors of Behaviour edited by Simon & Boyer (1970). A detailed description of the system is given in Chapter VII.

Statistics used:

(i) In order to establish the inter and intra observer reliability with respect to coding of the transcripts of the lessons, reliability coefficients by the Scott methods were found out. The minimum accepted level of observer reliability index was kept at 0.85.

(ii) Descriptive statistics such as mean, ratios and percentages were used to compare the subtle differences in the interaction patterns of methods.

A detailed description of the process analysis is given in Chapter VII.

As pointed out in Section 3.1.0, field study was designed in order to select the unit for the experiment and to decide about the duration of the experiment. Details about field study are reported in Chapter IV.