CHAPTER VIII

SUMMARY AND CONCLUSIONS:

8.1.0 INTRODUCTION:

Teaching is multivariate, complex and intentional human activity. Therefore, as a primary arena for learning the classroom teaching-learning process and its effects have long been the object of the research studies. In earlier times, these research studies were based on a fallacy, "There is probably certain kind of teaching which is really better than all other kinds." Therefore, investigators started to find out a single best teaching method across all types of pupils and for all types of purposes. But results were inconclusive and some times contradictory. Therefore, investigators started to study which method is suitable for which type of pupils. But the researcher is of the opinion that research should study the differences in the way how the content is taught and type of pupils to whom it is taught and for what purposes it is taught. With these types of studies one would be able to make statements like: for content material Y, taught by teacher Q to pupil Z, the best strategy is X.

If one reviews research studies on teaching one finds that, there are a number of controversies in the field. Out of these controversies, expository-discovery controversy is very old and many investigators have been undertaking studies
in this particular controversy. These studies are reviewed in Chapter II. Taking into consideration the various shortcomings of the earlier studies, the present study is designed and completed by the researcher. The title of the study was as under:

"A study of effects of expository and guided discovery methods of teaching mathematics on the achievements of students of different levels of intelligence."

8.2.0 OBJECTIVES OF THE STUDY:

i) Objectives related to presage-product:

a) To study the differential effect of guided discovery and expository method of teaching mathematics on the achievements of the students.

b) To compare the effects of guided discovery and expository methods of teaching mathematics on the achievements of students of different levels of intelligence, measured in terms of knowledge, comprehension and application objective.

c) To study the differential effects of guided discovery and expository methods of teaching mathematics on the retention of the students.

d) To compare the effects of guided discovery and expository methods of teaching mathematics on the retention
measured in terms of knowledge, comprehension, and applications objectives with respect to students of different levels of intelligence.

ii) Objective related to presage-process:

a) To study and compare interaction pattern associated with guided discovery and expository methods of teaching mathematics.

iii) Objective related to context-process:

a) To study the variation in interaction patterns due to change in levels of intelligence of students with respect to guided discovery and expository methods of teaching mathematics.

iv) Objective related to process-product:

a) To establish the relationship between interaction patterns associated with guided discovery and expository methods and achievement of students.

8.3.0 DEFINITIONS OF THE TERMS USED:

i) Expository method: If initial move of the teacher is the statement of the principle or generalization (followed by clarification, justification, and application moves) the sequence of moves is known as expository method.

ii) Guided discovery method: If the statement of the principle or generalization is not the initial move, but appears, if at all, near the conclusion of a sequence, the sequence is then called as guided discovery.
iii) **Intelligence test**: Raven's standard progressive matrices test used to measure the general mental ability of the students.

iv) **High intelligence group**: The students who secured percentile rank \( P_{75} \) or more on the intelligence test.

v) **Middle intelligence group**: The students who secured percentile ranks between \( P_{25} \) and \( P_{75} \) on intelligence test.

vi) **Low intelligence group**: The students who secured percentile ranks \( P_{25} \) or less on the intelligence test.

vii) **Students**: The students who were studying in grade VII from the two schools selected for the study during the year 1981-82.

viii) **Achievement of students**: The scores obtained on the test comprising knowledge, comprehension and application objective items based on the content 'volume'.

ix) **Knowledge objective**: Those behaviours or test situations which emphasize the remembering, either by recognition or recall of ideas, material or phenomenal.

x) **Comprehension objective**: Those objectives, behaviours or responses which represent an understanding of the literal message contained in communication.

xi) **Application objective**: Use of principles correctly in a given situation in which no mode of solution is specified.
8.4.0 ASSUMPTIONS OF THE STUDY:

Every scientific investigation is based on certain assumptions. The following were the assumptions of the study.

i) Teacher can be programmed to a great extent.

ii) Teacher behaviours are partially controlled by students' responses and to a large extent by method of teaching.

iii) There exists intra teacher variations in teaching.

iv) There exists relationship between the method and the interaction pattern of teaching.

v) There exists an interaction between method and student characteristics, and it varies with student characteristics.

vi) There exists variation in interaction pattern due to change in pupil characteristics.

vii) Pre-requisite/cognitive entry behaviour is essential for the subsequent school learning.

viii) Cognitive characteristics can be modified by a short treatment.

ix) Intelligence, aptitudes generalized characteristics are stable (or resistant to modification easily) to a large extent; therefore, these can be controlled experimentally.
x) Teacher behaviours are only partially controlled by students’ responses and to a large extent by method.

xi) Intelligence, achievement in mathematics are normally distributed.

xii) There is linear correlation between scores of prior and later achievement of the students.

8.5.0 SCOPE AND LIMITATIONS OF THE STUDY:

i) This study was limited to girl students selected from two schools from Pune City.

ii) Most of the students were from middle, upper classes of the society.

iii) This study was limited to only one unit i.e. 'volume' selected from the syllabus of grade VII Mathematics.

iv) In both the treatments, there was not the same, daily sequence of teaching for three different classes of students with different levels of intelligence.

v) The total teaching time for each treatment was limited to 9 school periods only.

vi) The number of students in each sub-group was limited to sixteen only.

The design of the study is discussed briefly in the next section.
8.6.0 DESIGN AND CONDUCT OF THE STUDY:

The study comprised two major aspects:

(i) Field study;
(ii) Experiment.

The details about field study and experiment are given in subsequent sections.

1) 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. In the present investigation, field study was undertaken for a specific but with a limited purpose. The objectives of the field study are given below:

a) Objectives:

a1) To select a unit of teaching for the experiment.

a2) To determine the number of periods usually required for the teaching of the selected unit.

a3) To study the methods of teaching adopted by the teachers.

a4) To collect the general information about the teacher and the classroom.

a5) To study various measures taken by the teachers to improve achievement of the students.
b) Collection of the data:

A questionnaire consisting of both open and closed-ended questions was developed by the researcher keeping in view the various aspects of the teaching of mathematics. The developed questionnaire was administered to the teachers teaching mathematics to grade VII. The analysis of the responses based on those given by 40 teachers was done by using mean, percentages, weighted means etcetera.

ii) Experiment:

a) Independent variable:

In the present study, expository and guided discovery methods of teaching mathematics were taken as qualitative independent variable.

As method interacts with pupil characteristics, intelligence of the pupils was also taken as another independent variable.

b) Dependent variable:

The present study was limited to achievement of the students in the cognitive domain only. Therefore, a test comprising test items based on knowledge, comprehension, and application objective based on unit taught during the experiment was constructed. The scores on knowledge, comprehension and application objectives were taken as dependent variables. Sum total of all these three scores was taken as one more dependent variable.
c) Control of extraneous variable:

Prior knowledge:

Mathematics has a hierarchical structure; therefore, studying any concept in mathematics requires some basic knowledge. The correlation between scores on previous achievement and subsequent achievement is very high. Therefore, while studying the effectiveness of two teaching methods this important factor needs to be controlled. In the present investigation, pre-achievement test was constructed on the previous knowledge required for the learning of unit 'volume'. This test comprising items based on knowledge, comprehension, and application objectives. The scores on knowledge, comprehension, application objectives and sum total of all these scores were treated as covariates. In short, prior-achievement was controlled statistically.

Teacher variability:

In order to avoid inter-teacher variations, only one teacher was involved in the study. The same teacher taught the unit 'volume' by both the methods.

Sex of the students:

Only girls' schools were selected for the study. Therefore, this variable was controlled fully.
Contamination:

In order to avoid contamination between two experimental treatments, two different experimental schools were selected which were away from each other and one treatment was employed in one school only.

Home-work:

Home-work also affects achievement of the students. Therefore, in order to control the effects of this particular variable, the students were given cyclostyled homework sheets on each of the lesson, during the experimental treatment.

d) Selection of the 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 effects of the treatments as well as interaction between the independent variables, method and the levels of intelligence. Therefore, the researcher selected the factorial design as a basic design. In order to control the effect of prior achievement of the students on post-achievement, the scores on 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 covariate. One factor 'method' was at 2 levels and another factor, intelligence at three levels high, middle, and low. Therefore, the design was 2 x 3 factorial design with covariate.
e) Conduct of the experiment:

**Selection of the subjects:**

- Raven's progressive matrices test of intelligence was administered to all the students belonging to grade VII from both the schools.

- Percentile rank of each of the students was found out.

- On the basis of percentile ranks, the students were categorized into three different levels of intelligence: high (PR ≥ 75), middle (PR between 25 and 75), and low (PR ≤ 25).

- VII A, VII C, and VII D divisions were selected 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 timetable. Similar procedure was adopted for the other school.

- Students were selected randomly from each of the divisions VII A, VII C, and VII D belonging to high, middle, and low intelligence levels respectively, from the first school.

- Then students belonging to VII A, VII C and VII D from high, middle and low intelligence from the first school were matched with those from the second school on a one-to-one basis.
Thus 16 students were selected from each of the six groups. Total number of students involved in the study were 96.

Administration pre-achievement test:

In order to measure previous achievement of the students, a test based on previous knowledge required for the learning of the unit 'volume' was administered to the students prior to the application of experimental treatments. This test was based on knowledge, comprehension, and application objectives. The scores on this test were treated as covariates.

Application of the experimental treatments:

Experimental treatment consisted of teaching of the unit 'volume' by two methods: expository and guided discovery methods of teaching mathematics to three different levels of intelligence groups. Teacher taught unit 'volume' in one school by expository method in the month of November 1981 and same teacher taught unit 'volume' in another school by guided discovery method in the month of January 1982. High, middle and low intelligence groups were taught separately by expository and guided discovery method by the same teacher. The experimental treatment continued for 9 days, one period each day. The total number of lessons was 54.

Collection of the teaching process data:

In order to study the interaction patterns associated with expository and guided discovery methods of teaching mathematics, and variation in interaction pattern due to change in levels of intelligence, all the lessons given by the teacher
were audiotaped. In order to supplement the information obtained from audiotape, the data with respect to non-verbal activities were collected by using two specially developed proformas by the researcher.

Administration of post-test:

After completion of the experimental treatment of 9 days, on the 10th day a post-test based on unit 'volume' taught during the experiment was administered to the students. This test comprised test items based on knowledge, comprehension, and application objectives. The test was of 50 marks and the duration was 1½ hours.

Administration of retention test:

In order to measure the effectiveness of expository and guided discovery methods of teaching on the retention of the students, the same post test was administered to students after three weeks of the conclusion of the experiment.

Scoring of pre-achievement and post tests:

Answer scripts of the students were assessed by using scoring key for objective type of items and marking scheme for short answer and essay type questions. Out of 96 students who participated in the experiment, data with respect to 72 students only analyzed. The data with respect to 24 students rejected because of (a) absence for more than one teaching period, (b) absence either for post test or pre-achievement test.
8.7.0 **ANALYSIS OF THE DATA:**

i) **Analysis of the post test data:**

Post test consisted of test items based on knowledge, comprehension and application objectives. The scores obtained by students on knowledge, comprehension and application objectives were taken as knowledge scores, comprehension scores, and application scores. Sum total of all these scores was taken as total achievement scores. Similar scores were also obtained for pre-achievement test. Knowledge scores on post test were adjusted using knowledge scores on pre-achievement test as covariate. These scores were analysed by ANOCOVA technique. Similar analyses were carried for comprehension, application, and total achievement scores.

ii) **Analysis of the retention test data:**

The same post-test was administered after three weeks to the students. If particular item was correct on both the occasions that is on post test and retention test then only it was treated as retention of that particular item. In this way, all the retention scores with respect to knowledge, comprehension and application objectives and total achievement were found out. By treating scores with respect to different objectives as base, percentages of retention of scores were found out. These percentages of retention with respect to knowledge, comprehension, application and total achievement scores were analysed by ANOVA technique.
iii) Analysis of the process data:

Audiotapes with respect to all the 54 lessons were transcribed by the researcher. Three seconds' interval was marked on all the transcripts of the teaching process.

The data was coded by using observational system of Instructional Analysis. Prior to coding the lessons, both inter-observer and intra observer reliabilities were established. Lessons with respect to expository and guided discovery method were encoded by using OSIA. Interaction patterns associated with these two methods and variation in interaction patterns due to change in levels of intelligence of the students were studied by different methods such as (a) finding out percentage of time spent on 16 categories of OSIA, (b) percentages of time spent on various area of interaction matrix, and (c) different interaction ratios. The difference between two interaction patterns was tested by using 't' test.

8.8.0 FINDINGS AND CONCLUSIONS OF THE STUDY:

i) Findings of the field study:

Keeping in view the objectives of the field study, the following findings were arrived at by the researcher on the basis of analysis of the data.

a) According to teachers, unit 'volume' was most difficult unit for teaching and it requires about 12 periods for teaching. Therefore, the researcher selected the unit for the experiment.
b) Fifty percent of teachers involved in the field study had experience of teaching more than 10 years.

c) Teacher-pupil ratio was 1:55 and classes were overcrowded as far as area per pupil was concerned.

d) Teachers were using different types of written material in teaching. Text books, and question banks were maximally used by the teachers.

e) Chalkboard, models, graph board were some of the teaching aids used by teachers, whereas Spikeabacus, films, and filmstrips were not used by the teachers at all.

f) Activities like, drawing of figures, folding of papers, cutting and pasting of the papers were organised by the teachers in the classroom.

g) Inductive, lecture, and activity methods were preferred by the teachers, whereas problem solving method, guided discovery method, laboratory method were least preferred by the teachers.

h) With respect to different subunits from the syllabus the teachers were using the expository method to a large extent than the guided discovery method.

i) Solving different types of examples, asking students to construct examples, periodical revision were some of the special efforts made by the teachers in order to increase the achievement of the students.
ii) Conclusions of the presage-product study:

a) Conclusions with respect to post-test data:

ai) There was no significant difference between achievement of the students with respect to scores on knowledge objective taught by expository and guided discovery methods of teaching mathematics after removing the effect of pre-achievement with respect to knowledge objective.

a(ii) There was no significant difference between achievement of the students with respect to scores on comprehension objective, taught by expository and guided discovery methods of teaching mathematics, after removing the effect of pre-achievement of the students with respect to comprehension objective.

a(iii) Expository method was more effective than guided discovery method in respect of achievement of the students of high intelligence with respect to scores on application objective after removing the effect of pre-achievement of the students on application objective.

a(iv) There was no significant difference between achievement of the students of middle intelligence taught by expository and guided discovery methods with respect to scores on application objective after partialling out the effect of pre-achievement of the students on application objective.
av) There was no significant difference between achievement of the students of low intelligence taught by expository and guided discovery methods with respect to scores on application objective after removing the effect of pre-achievement of the students on application objective.

avii) Expository method was more effective than guided discovery method with respect to total achievement scores of the students after removing the effect of pre-achievement with respect to total achievement.

aviii) Expository method was more effective than guided discovery method with respect to total achievement scores of the students of low intelligence after partialling out the effect of total achievement on pre-achievement test.

b) Conclusions with respect to percentage of retention:

bi) Expository and guided discovery methods were equally effective on the criterion of percentage of retention scores with respect to knowledge objective.

bii) Expository and guided discovery methods were equally effective on the criterion of percentage of retention scores with respect to comprehension objective.

biii) Guided discovery method was more effective than expository method on the criterion of percentage of retention scores with respect to application objective.
biv) Guided discovery method was more effective than expository method on the criterion of percentage of retention of total achievement scores with respect to students of middle intelligence.

In short, one can conclude that,

Guided discovery method and expository method were equally effective on knowledge and comprehension objective with respect to immediate post-test as well as on retention test.

Expository method was more effective than guided discovery method on the criterion of scores on application objective with respect to students of high intelligence.

Guided discovery method was more effective than expository method on the criterion of percentage of retention scores on application objective in case of students of low intelligence.

Guided discovery method was more effective than expository method on the criterion of percentage of retention scores with respect to total achievement of the students of middle intelligence.

c) Conclusions with respect to presage-process study:

cl) The interaction pattern associated with expository method of teaching mathematics was as follows:

- **Teacher initiates information** → **Teacher demonstration** → **Teacher requests & commands**
cii) The interaction pattern associated with guided discovery method of teaching mathematics was as follows:

Teacher questions → Silence & contemplation → Student response

ciii) Expository method was associated with direct pattern, whereas guided discovery method with indirect pattern.

civ) Lengthy lecturing, demonstration, and directed practice were the features of expository method, whereas lengthy questioning, silence, and students' answers were the features of guided discovery method.

d). Conclusions with respect to context process study:

Expository Method:

di) There was significant difference between high and middle intelligence group with respect to Category 7: corrective feedback. Therefore, in order to elicit responses from middle intelligence group, teacher used more corrective feedback than high intelligence group.

dii) There was significant difference between high and low intelligence group with respect to Category 9: criticism and rejection. Therefore, in order to elicit the responses from the low intelligence students the teacher had to use more criticism and rejection than high intelligence group.
diili) There was no significant differences between middle and low-intelligence groups with respect to all the sixteen categories.

div) None of the differences between percentages of time spent on different regions with respect to all the three levels of intelligence were statistically significant. However, teacher's indirect influence was more in high intelligence than in middle and low intelligence group.

dvi) Teacher was more responsive towards pupils' ideas and feeling as compared with criticism and rejection in high intelligence than in middle, and low intelligence groups.

dvii) Teachers indirectness decreased as there was decrease in level of intelligence of the students.

e) Guided discovery method:

ei) Students of high intelligence group asked more questions than those of middle intelligence group.

eii) While teaching to middle intelligence group the teacher used more requests and command than low intelligence group.

eiii) While teaching to low intelligence group the teacher used more corrective feedback and criticism and rejection than high intelligence group.
eiv) None of the differences between percentages of time spent on different regions of the interaction matrix were statistically significant. But teachers' direct influence increased when intelligence level of the student decreased.

ev) Teacher was more responsive towards pupils' ideas and feelings as compared with criticism and rejection in high intelligence group than middle and low intelligence group.

evi) There was high and rapid interaction in low intelligence group as compared with high and middle intelligence groups.

evii) Teacher was more indirect in high intelligence group as compared with middle and low intelligence group.

eviii) Due to change in level of intelligence of the pupils there was change in teachers' response ratio, pupil initiation ratio, teacher indirectness, steady state ratio, and pupil steady state ratio.

f) Conclusions with respect to process-product study:

Expository method was more significantly effective than guided discovery method on the criterion of scores of application objective test items in case of students of high intelligence because of the following process variables -

1) teacher demonstration
2) extended directed practice
3) extended teacher demonstration
4) ratio of sustained behaviour to transitional behaviour.
8.9.0 RECOMMENDATIONS:

Since the present investigation is related to 'research on teaching', it has implications for both the teaching of mathematics as well as to teacher education. The following recommendations are based on results of the study.

i) Recommendations to the Teachers:

(a) The softwares such as lesson plans based on expository and guided discovery methods, pre-achievement test post test, transcripts of the lessons are useful to the teachers. The hardwares developed in the study also are useful to the teachers.

(b) The researcher was interested in finding out interaction patterns associated with the guided discovery and expository methods of teaching, therefore, only 16 students were involved in each of the group. 16 sets of cuboids were prepared for generalizing the formula for finding out the volume of the cuboid by inductive discovery. If more sets are prepared, then the same approach can be adopted in large classes also. It may result into same effectiveness.

(c) It was found that expository and guided discovery methods of teaching were equally effective on the criteria of knowledge and comprehension objective with respect to different levels of intelligence groups. Therefore, the teachers should make use of either expository or guided
discovery if knowledge and comprehension objectives are to be attained.

(d) It was found that on the criterion of application objective expository method was more effective than guided discovery method in case of high intelligence group. Hence, teacher should make use of expository method while teaching to high intelligence group.

(e) Guided discovery method was more effective than expository method to the extent that students' ability to retain mathematical knowledge taught to them, guided discovery method should be an integral part of methodology of teaching mathematics to grade VII students.

ii) Recommendations to teacher education:

(a) Effectiveness of expository and guided discovery method depend upon objectives of teaching as well as on level of intelligence of students. Therefore, training in both the methods and their use in particular situation could be given to student teachers.

(b) Guided discovery and expository methods are related to indirect and direct patterns of teaching respectively and therefore, while guiding to student teacher for methods, training in respective patterns of teaching should be given.
In an attempt to find out solution to a particular problem, during the process of solving the problem many problems are generated. This is because of insight gained by the investigator. In the present investigation the following problems were found worth researching.

i) The present investigation was limited to only one teaching unit 'volume', taught by only one teacher in two different schools. Similar study can be undertaken for more than one unit taught by a number of teachers involving more than two schools.

ii) 'Total teaching time' was kept constant in all the six groups irrespective of either method or level of intelligence of the students. Effect of these two methods can be studied by keeping 'content' constant (i.e. number of problems to be solved in each group) and varying the amount of teaching time on the achievement of the students of different levels of intelligence.

iii) Students were categorized into three different groups: high intelligence (percentile ranks \( \geq P 75 \)), middle intelligence (percentile ranks between \( P 25 \) and \( P 75 \)) and low intelligence (percentile ranks \( \leq P 25 \)). A similar study can be undertaken by narrowing the range of intelligence of each group.
iv) Change in interaction patterns due to change in level of intelligence of students as a context variable, with respect to guided discovery and expository method of teaching mathematics was studied. Other context variables such as aptitude of the students, attitudes of students towards mathematics, pre-achievement of the students, socio-economic status, grade level, should be considered for studying the context-process relationships with respect to expository and guided discovery methods.

v) In the present investigation intelligence and prior achievement were controlled experimentally and statistically respectively. But similar study can be undertaken by controlling prior achievement experimentally and intelligence statistically.

vi) It was observed that, if proper guidance is given to the low intelligence students, they can give as good responses as those given by the students from high intelligence group. Therefore, the effect of change in amount of guidance (as a process variable) on the achievement of the students may be studied.

vii) The effectiveness of expository and guided discovery method was judged in terms of students' achievement i.e. product variable only. The effectiveness of these two methods can be studied in terms of process variables by developing interaction ratios.