Chapter IV

METHOD AND PROCEDURE

Introduction

The present study entitled "Effect of constructivism on mathematics achievement of grade V students in Nepal" is essentially experimental in nature. It was designed to examine the effect of constructivism on mathematics achievement. Achievement was measured in terms of basic skills: cognitive and non-cognitive outcomes. Cognitive outcomes were measured through achievement test and non-cognitive outcomes were measured in terms of attitude of the students' towards mathematics and the habit of independent learning.

Much of educational research on school or teacher is directed to study the basic skills of numerical operations as dependent variable, but in this study, non-cognitive outcomes such as habits of independent learning was also considered. That is why in this study both quantitative as well as qualitative methodologies were combined.

This chapter presents the design of the study, sample, selected variables under study, and the chapter ends with a schematic chart of the route map to carry out the research. The study was conducted in phased manner.

Design of the Study

The study involved pretest, posttest; quasi-experimental-control group design. According to Campbell and Stanley (1969, p.34):

"There are many natural social (classroom) settings in which the research person can introduce something like experimental design into his scheduling of data collection procedures (e.g., the when and to whom of measurement), even though he lacks the full control over the scheduling of experimental stimuli (the when and to whom of exposure and the ability to randomize exposures) which makes a true experiment possible. Collectively, such situation can be regarded as quasi-experimental designs. But just because full experimental control is lacking, it
becomes imperative that the researcher be thoroughly aware of which specific variables his particular design fails to control.”

According to Best & Kahn (1986) when experimental and control groups are such naturally assembled groups as intact classes, which may be similar, then quasi-experimental design involving pretest, posttest non-equivalent groups may be the only feasible ones. But Best & Kahn further suggest that the results should be interpreted cautiously.

In view of the above, the present study is the quasi-experimental using pretest, posttest non-equivalent group design. In this design delayed posttests were also given to both the groups for the purpose of ascertaining the retention power of the students for the contents which were taught.

The present design is quasi-experimental in the sense that neither the selection of schools nor the treatment were randomized. The experimental group was selected purposively and control group was selected by matching them with respect to the type of school mainly private and public schools, infrastructure and teacher's characteristics.

The following diagram, figure 4.1, given below indicates the course of action taken by

---

Figure 4.1: SELECTION OF DESIGNS AND RESEARCH STRATEGIES PRESENTED IN THIS TEXT
the investigator. The sample consists of four schools. So, the answer to the question "Is the sample being studied as a group or one subject" is "A group". The answer to the question, "Are the subjects randomly assigned to condition" is No. Because two experimental schools were purposively selected. For the third question, "Has the experimenter functional control over independent variable(s)?" The answers bifurcates here in the form: both Yes and No. The investigator had some control over some of the variable described on Appendix M. In the meantime the investigator was not able to control all the variables which affect the dependent variable "Achievement". So, the analysis was done in two ways one in quantitative following the answer Yes and another in qualitative following the answer No.

The answer to the fourth question of the tree diagram leading to quantitative method, "Is there a control group" is Yes. For the fifth question, "How many observations are being made?" the answer is 2 (pretest and posttest). Delayed-posttest was needed since it was aimed to test the objective retention. So, the design of this study in tree diagram is the same as suggested by design number 10 according to Campbell & Stanley (1969 ed. fifth). (See Appendix L)

Besides the statistical test, a lot of qualitative information were to be collected during the experimentation period. Freeman (1962, p. 138) writes:

"Statistical validation of a test item is not always sufficient; it must be supplemented by pragmatic criterion of use with a wide variety of individuals in a variety of situations in order to show whether or not it has discriminative value among individuals at the several level of ability."

The answer to the fourth question leading to qualitative method, "What type of measurement does the investigator make?" is: oral, written and observation. These are the qualitative data which demands qualitative technique in order to analyse.

Field of investigation

The field of investigation was grade V of secondary schools of the Kathmandu valley in Nepal.
Samples of the Study

In accordance with the nature of the study, multistage sampling was done with respect to
(a) selection of schools  (b) selection of the section in the class (c) selection of teachers.

Selection of Schools

There were altogether four schools taken up for this study. Two schools namely Laboratory
Secondary School (LAB) and Mangal Secondary School (Mangal) were selected as experimental
schools. These schools were named in this research as Project-Schools. The other two schools
namely Mahendra Adarsha Vidyamandir (MAV) and Gyanoday Seconadary School (Gyanoday)
were taken as the control schools. One of the project-schools was public school namely Mangal
and another school was private school namely LAB school. Similarly one of the control schools
was public school namely Gyanoday and other school was a private school namely MAV.

The selection of schools was primarily purposive in nature with respect of the distance
so that the investigator could commute from one to another school daily; and secondly with
respect to the willingness of the schools to cooperate and tryout a new approach.

Selection of a Section in a Class

In a school, where in grade V, there were more than one sections random method was
used to select a section for the experiment. The beak up of the sample is given below.

Table 4.1: Break up of the Student's Sample

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Name of the School</th>
<th>Number of Students</th>
<th>Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>1</td>
<td>Gyanoday Sec. School</td>
<td>36</td>
<td>25</td>
</tr>
<tr>
<td>2</td>
<td>Mahendra Adarsha Vi.</td>
<td>21</td>
<td>11</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory Sec. School</td>
<td>21</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Mangal Sec. School</td>
<td>25</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>103</td>
<td>77</td>
</tr>
</tbody>
</table>

Teachers' Sample

The mathematics teacher, teaching to grade V of sampled schools comprised the teacher's
sample. A total number of teachers was four.
Variables Studied

In an experimental study there are many independent and dependent variables. These are described below:

Independent/Treatment Variable

In this study the treatment variable was method of instruction/strategies used in the classroom instruction in accordance with the characteristics of constructivism.

Dependent Variables

Learning outcomes i.e. achievement in mathematics and non-cognitive variables habit of independent learning were the dependent variables in this study.

Non-experimental Variables

Length of class period, time of the day, levels of school, teacher characteristics, student characteristics, content taught, teaching aids, tests and marking procedures etc. were the non-experimental variables.

Controls Exercised in the Experiment

Since the aim of this study was to examine the effect of constructivism on mathematics achievement of grade V students, it was imperative to detect and nullify the effect of other variables besides the experimental variable which might influence the achievement. They were school variables, teacher variables, student variables and the contents. For this, the following exercise was done to control the variables.

School Grading

Two sampled schools of control group were equally reputed in comparison to two sampled schools of experimental group.
Teacher Variable

Teacher variable was viewed in terms of general characteristics and professional skills of the sampled teachers:

General Characteristics

To reduce the variation in the personality and individual differences of the teachers, equally qualified, experienced teachers were selected. The type of tenure (permanent, temporary or contract) were also considered while selecting teachers. Table 4.2 reports the status of mathematics teachers:

Table 4.2 Schoolwise General Description of Math Teachers

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Variable</th>
<th>Gyanoday (control)</th>
<th>Mangal (Experim)</th>
<th>Laboratory (Experim)</th>
<th>Mahendra (control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.</td>
<td>Length of experience</td>
<td>4 Yrs</td>
<td>4 Yrs</td>
<td>20 Yrs</td>
<td>18 Yrs</td>
</tr>
</tbody>
</table>

Professional Skill of the teachers

To ensure that experimental group and control group were equal with respect to professional skills of the teachers, observation of the project-teacher's performance was recorded by using the Classroom Observation Form (see Appendix K) developed by Pennsylvania University USA. These include:

(a) Pupil learning: Indicator of good Learning;

(b) Teacher’s Plan for learning: Indicators of well-planning;

(c) Pupil preparation: Indicators of preparedness;

(d) Pupil vocabulary: Indicators of rich vocabulary;

(e) Pupil creativity: Indicators of creativity; and

(f) Learning Process: Indicators of good methodology.

-45-
It was observed that all the teachers performed more or less similar to the other in all the aspects above. Teacher's other characteristics such as: **aptitudes, value and attitude and their expectations**, do play very important role in students' achievement which were not considered in this research.

**Equate the Groups**

In this study the experimental and control groups were equalled with respect the student background, curriculum i.e. the subject matter and material used in the class and evaluation of the students.

**Students' Background**

In order to equate the groups, at the pre-experimental stage the investigator visited different schools and collected information about students' characteristics through different measures such as: i) Background data; ii) Attitude towards mathematics; and iii) Intelligence.

(i) **Student Survey Form** was used for the background information. It is given in the Table 4.3 below.

### Table 4.3: Schoolwise General Description of Students

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Variable</th>
<th>Gyanoday</th>
<th>Mangal</th>
<th>LAB</th>
<th>MAV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>No. of students</td>
<td>63</td>
<td>53</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td>2.</td>
<td>Average Pre-school exposure in years</td>
<td>1.86</td>
<td>2.75</td>
<td>2.57</td>
<td>2.38</td>
</tr>
<tr>
<td>3.</td>
<td>Social Background</td>
<td>Mixed</td>
<td>Mixed</td>
<td>Mixed</td>
<td>Mixed</td>
</tr>
</tbody>
</table>

(ii) **Student attitude inventory** was used to measure their attitude towards mathematics which was found to be moderate in all the schools.

(iii) **Intelligence**: For the measurement of intelligence, ratings were obtained from teachers who had been teaching the group since the last year and knew the students
individually. They were requested to rate their students in terms of below average, average and above average. It was found that in all the four schools the teachers rated their students as average which ensured the equating of the student's ability.

On the basis of the above data, the students were equated.

Subject Matter

In all the four schools similar contents were taught from the same textbooks prescribed by the Government of Nepal.

Teaching aids used

The instructional materials prepared and/or collected by the investigator for project schools were also provided to control group students with a view to reduce the variation of teaching aids.

Evaluation

After the end of the experiment the same test was given to control and experimental groups. The marking scheme of the test was either 1 or 0. The investigator was always alert to see students' creativity and their own way of answering the problem. The investigator himself marked the test paper of students. So, the variation in marking of test paper was also reduced.

Tools Used in the Experiment

There were several tools used for the purpose of data collection:

(i) Attitude Towards Mathematics (Aichele & Reys 1973)

This is an inventory to measure student's attitude towards mathematics. The aim of using this inventory was to see if any difference can be notice between two groups of students. The students were given this inventory twice, one in the beginning and another on completion of the study. Negative statements have reverse ordeer marking to positive statements. This inventory is given vide Appendix I.
(ii) Classroom Observation Form (The Pennsylvania School study Council)

This is a check list designed for the supervisor/mentor. The aim of using this was to see/judge whether or not the classroom teaching is up to the mark. The mentor used it sixteen times (approximately 4 times a month) during the period of this study. For this purpose both the investigator and the mentors used it several times. In order to assure the inter-observer reliability between the investigator and mentor, correlation coefficient was calculated and found more than 0.85 which was satisfactory. This correlation coefficient shows that mentors' observation was very similar to that of the investigator. The scoring criterion of this checklist is given vide Appendix K.

(iii) Observation Checklist for Student's Reflective Behaviour (Shell Centre for Mathematical Education)

This checklist is designed to see the student's reflective behaviour assessed by the investigator. The aim of using this check list was to see if any difference can be noticed between two groups' of the teachers. The investigator himself used it sixteen times (approximately 4 times a month) during the period of this study. Marking scale is given on the checklist vide Appendix J.

iv) Achievement test

In each of four contents Fraction, Measurement, Equation and Angle selected for the experiment, the investigator prepared three parallel form of achievements. Each form included contents to measure three levels of cognitive domain (a) conceptual understanding (b) procedural understanding (c) application level. The Kuder-Richardson reliability coefficients ranged from 0.609, 0.612 and 0.620 for different achievement tests (pretest, posttest, and delayed-posttest) respectively. These tests are given vide Appendix E.

v) Interview Schedules

Interview schedules for different personnels were prepared and validities were established through expert judgement. The interview schedules are given vides Appendices F,G and H.
Procedure Followed to Conduct the Study

As per requirement, the study was conducted in three phases:

(a) Phase I: Pre-experimental Stage, (b) Phase II: Experimental Stage, (c) Phase III: Post-experimental Stage.

Phase I: Pre-Experimental Stage

In this phase collection and or preparation of instructional materials, preparation and standardization of teaching-episodes, achievement tests and interview schedules were prepared. At this stage the training of teachers was done to teach the students according to constructivism. At this stage pretest (achievement test), was administered to the students. Along with this attitude towards mathematics was also measured before the experiment began.

Phase II: Experimental Stage:

Actual experiment was conducted in Phase II. Both groups were engaged in learning process through two different methods of teachings. In this way both groups got two different treatments and then the effect of these two methodologies were evaluated with the help of the posttest and delayed-posttest scores.

Phase III: Post-experimental Stage

Posttest were administered four times immediately after finishing each unit i.e. Fraction, Measurement, Equation and Angle. The aim of posttest was to see the immediate effect of the treatments. Whereas delayed-posttests on each topics were administered on the gap of 20-30 days after respective posttests.

Data collection

Before each test pretest, posttest and delayed-posttest the teacher/mentor read aloud all the instructions. Students were told to answer, the different steps in each questions. If they were not comfortable to answer as they were expected then they were allowed to give solution in
their own way. Since constructivism encourages autonomy in answering as well, so this part was also taken into consideration. Each test was of 45 minutes duration.

Observation of Classroom Teaching

The investigator observed the class to answer the following:

- How the process of constructivism was followed?
- What was the children’s method of solving problems?
- Which were the situations where students were engrossed and learn independently?
- Whether discrepancies occurred or not between teachers’ and students’ expectations?
- Problems that the students encountered on certain tasks;
- The changing attitudes of the students and project teacher towards constructivism.

As per requirements of the study, the investigator had to be simultaneously involved in teaching as a facilitator (insider) and also acted as an observer (outsider) to reflect on the classroom behaviour.

Best (1986, pp. 160-161) writes:

"When researchers are sole observers, they unconsciously tend to see what they expect to see and to overlook those incidents that don’t fit their theory. Their own values, feelings, and attitudes, based on past experience, may distort their observations. It may be desirable to engage several others who are well-prepared as observers”.

That was the reason why mentors were requested to participate in this project. For the reliability of the observation of the investigator the mentors were occasionally asked to observe the class of the project teachers in his presence.

Interview

Each interview was meant for a different purpose, although some questions were repeated in order to provide a comparison of responses. Each interview was carried out by the investigator with an audio-tape records. Full transcripts of the interview tapes were made and these were used for the later analysis.
An attempt was made to see if the child preferred one's own method. The intension of the researcher was to monitor the transition from child-method to more logical consensus method through hands-on experience. The interviews were done formally as well as informally.

The interview/interaction was aimed at to know:

• How do you feel about the way of teaching?
• How do you feel about their own way of doing?
• Do you feel that you can learn independently?
• Do you differ at times, from their teacher?

Interviews were also taken:

• to investigate the common misconception of students.
• to investigate the common errors done by the students in written work on topics of fraction, measurement, equation and angle.
• to investigate the student's method of doing and justifying their work.

Two students from each of four schools were interviewed, for each content to know about their performance on pretests, posttests and delayed-posttests. The pretest interview was used to ascertain familiarity with prerequisite knowledge and to find out if the children already knew and used the formal method.

This extends to the indications of the students' working level started from the base line information (pretest) and the rise in the level which occurred during their individual learning processes to posttest score.

Their personal academic progress were discerned through arrow diagram.

Researcher Observation

The investigator kept a regular diary to trace his insight about the effect of new way of teaching (Eisenhart, 1988). With the objective to judge whether students were making meaning of what they observe, hear, and work out in their group.

Millory (1992) has given six observable behaviours given below which are taken as an indicator of mathematizing. These are:
1) explain something to the class verbally
2) take some action on a problematic task
3) engage in reflection
4) offer some argument for verification
5) appraise some work critically
6) work with a more able peer, or act as a more able peer

If any student is seen involved in any of the above activities then it shows that (s)he is making sense, transferring his knowledge to higher level and engaged in self-learning and self-correcting meaningfully.

Scoring the Data

Since the achievement test had questions of different levels, the weightage for each type of questions varied according to the order of difficulty. Knowledge level question measuring conceptual understanding, demands simple information which carried 1 point as a score. Whereas the comprehension level questions, measuring procedural understanding, demands both the information and skill. So, the weightage for these types of questions was 3 points each. Similarly application level questions are of the highest level which demands both knowledge as well as comprehension level (skill). So, the weightage assigned for these types of questions was 5 marks.

For maintaining the objectivity in marking, each set of questions was prepared showing the steps as how to answer the different questions. For details see Appendix E.

Techniques Used to Analyse Quantitative and Qualitative Data

By applying ANCOVA to the quantitative data, the difference in immediate learning, retention of learnt things, and net gain were calculated. The means of pretest scores and posttest scores of both types of groups were found. On the basis of the mean score obtained by the both groups, the conclusion was drawn about the effect of constructivism by using SPSS 10.00 with the help of computer. The conclusion were also based on the line graphs drawn for different activities.

By applying mixed strategies to the qualitative data, the possibility of constructivism, the habit of self-learning and self correcting, the situation where learning occurred independently as well as the difference in expectations of teachers and students were identified. The transfer of knowledge and skill were also addressed by qualitative analysis. On the basis of interviews, excerpt on test paper, and observation the qualitative inferences would be made by validating
the information by the method of triangulation.

So, the planning for the chapter "Analysis and Interpretation" is given in the Schematic chart given by citing the aim of the study, different activities such as: sample selection, training of the teachers, preparation/standardization of the teaching episodes and achievement test. The schematic chart describes in detail how the analysis was performed in this study.

Figure 4.2 Schematic Chart for Analysing the Present Study