CHAPTER III

METHOD AND PROCEDURE

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3.0.0 Introduction

As it has been stated earlier (Chapter I) the present study is an experimental investigation. It aimed at studying the effects, if any, of the four strategies of teaching, that is, Lecture, without discussion (St_1), Lecture with discussion (St_2), Lecture with discussion and practical work (St_3) and Lecture with discussion, practical work and use of Audio-visual Aids (St_4), upon the achievement and creative thinking of seventh class pupils in science in terms of achievement, fluency, flexibility and originality. Data were collected keeping in the mind the objectives of the study as stated in chapter I, under caption 1.7.4 and to test the hypotheses of the study as stated in chapter I under caption 1.7.5 by conducting an experiment on the seventh class pupils of the secondary school. The experiment was carried out for fourteen weeks in the year 1978. Table 3.1 on the next page gives a brief picture of the experiment.

As is clear from Table 3.1 the Latin Square Design was followed in the study. This design has some advantages and disadvantages because of the different variables that act in an experiment in education. The Latin Square Design is superior in its efficiency over even some sophisticated designs. In its efficiency it has gain of forty five percent

Table :3.1: A Brief Picture of the Experiment conducted in the Study

Design	Units of Teaching	Treatment Variables	Group of Pupils	Duration of Experiment	Tests	Other Tools
4 X 4 Latin Square Design	Four	Four	Four	Four sessions (Total 14 weeks)	(i) Four Achievement Tests (ii) Four Creative Thinking Tests	1. I.Q. Tests 2. Achievement Tests 3. Torrance Test of Creative Thinking (TTCT)

over complete randomization and gain of nine percent over randomized block experiment (Snedecor and Cochran 1967). But design requires an assumption that interactions due to various factors are zero. It involved four units to be taught and hence it is not certain to what extent the assumption holds good implicitly. As seen from Table 3.1 four groups of pupils were involved in the experiment which continued for four sessions. Four units of teaching formed the content for the experiment. Services of four teachers were utilized in the study. There were four treatment variables and to see their effect on achievement and creative thinking, four achievement tests and four creative thinking tests were developed. In addition to these tests, the Torrance Test of Creative Thinking (T.T.C.T.) and Dr.Champaben Bhatt's I.Q. Test and pre-achievement test were used to describe the sample. Details regarding the design of experiment, the sample on which it was conducted, the treatment that was given, the tools that were used, the procedure that was followed, and the statistical techniques that were employed are discussed below under separate captions.

3.1.0 Design

The following issues were considered before selecting the design for experiment :

(a) There were four teaching strategies as experimental treatments.

(b) It was thought to test these strategies over some teaching units.

(c) If a single group of students was taught four teaching units through the four teaching strategies the difference in the teaching units would have proved to be a major source of variance. The same unit could not be taught repeatedly because of the resultant carry-over effects.

(d) If the same unit was taught to four different groups of students through the four teaching strategies, the pre-treatment differences of the groups would have proved to be a major source of variance.

(e) Randomly alloting the students to the four groups might not have been possible due to administrative reasons.

(f) Economy, from the point of research, that is, to get much information from relatively small number of observations, was kept in view.

With all the above considerations, the experiment involved a Latin Square Design. There were four strategies of teaching and to fit them into the design, four groups of pupils, four teaching units of content and four sessions were taken up

and the design thus turned out to be a 4 X 4 Latin Square Design. Each cell had about twenty four replicates in it. By arranging the observations in this form, a large amount of information can be extracted from a relatively small number of observations (Walker and Levish 1953). Out of the many possible 4 X 4 Latin Squares,one which was used in the experiment is given in Table 3.2.

Table :3.2: Experimental Plan of the 4 X 4 Latin Square

A	B	C	D
B	C	D	A
C	D	A	B
D	A	B	C

The above Latin Square Design used in the experiment runs as given in Table 3.3

Table :3.3: Latin Square Design followed in Experiment

Units	Group I	Group II	Group III	Group IV
I	St_1 T_1	St_2 T_1	St_3 T_1	St_4 T_1
II	St_2 T_2	St_3 T_2	St_4 T_2	St_1 T_2
III	St_3 T_3	St_4 T_3	St_1 T_3	St_2 T_3
IV	St_4 T_4	St_1 T_4	St_2 T_4	St_3 T_4

Group I, Group II, Group III and Group IV are the four groups involved.

Strategy 1, Strategy 2, Strategy 3 and Strategy 4 are the four teaching strategies.

Teacher 1, Teacher 2, and Teacher 3 and Teacher 4 are teachers for the correspondents unit. They are expressed in the following way in Table 3.3 :

Groups = G_I , G II, G III and G IV

Strategy = St_1 , St_2, St_3 and St_4

Teacher = T_1, T_2, T_3 and T_4

Each cell represents an experimental situation involving a Unit being taught by a particular teacher using a particular teaching strategy or the treatment variables. Each such combination was taught for ten successive days as each unit comprised of ten lessons. After teaching the Unit completely i.e. after teaching for ten days, the corresponding achievement and creative thinking tests were administered, on the next day. Each group was exposed to all the Units, all the strategies and all the teachers, and the time was kept constant. It is to be noted that this design has got on underlying assumption that interactions are zero. The design envisages overcoming of certain common difficulties. Since each group is exposed to all the Units and all the teaching strategies the environmental variance can be considered as

having no serious influence on the treatment. Almost equal teachers, after being sufficiently programmed, teaches through all the teaching strategies and so it can be assumed that the variance due to teacher on the treatment variable is negligible.

One basic condition in the analysis of variance of Latin Square Design is that the observations for the different treatments are independent. That is to say, the value of an observation for one treatment is not dependent on the effects of the treatments applied during earlier periods.

In the experiment in education there is always the possibility of carry over effects, when the same subjects are given a series of different treatments. It is suggested that one way in which the experimenter may hope to eliminate the possibility of carry over effects, when the same subjects are tested under all treatments, is to increase the time interval between the various periods in which the treatments are applied (Edward 1968). Keeping in view the treatment carry over effects and the school situation, a gap of four days between the treatments was planned in this experiment. (It seems unlikely in cases such as these described, that carry-over effects could be eliminated completely, even though there is a relatively long interval of time between each of the successive treatments).

Instead of the same group receiving the different treatments, here there are four groups of subjects covering all the sixteen experimental conditions. In the design followed the columns represent the groups. The same groups are subjected to the different treatments, as per the schedule in the design. Therefore, this design may be considered as repeated measures design. One can expect repeated measures design to be considerably more powerful than designs utilizing completely random groups of experimental subjects and at least somewhat more powerful than randomized block experiments. The use of repeated measures also reduces the number of experimental subjects required to conduct an experiment (Dayton 1970).

3.2.0 Variables

Treatment and Criterion : The four strategies as mentioned in caption 3.0.0 served as the treatment variables for the present study. The details about the selection and nature have already been given in caption 1.7.1.

The criterion variables in the present study relate to measures of pupils achievement and creative thinking. The details of the objectives have been given in caption 1.7.4.

3.3.0 Intervening Variables

The design of this study is likely to allow two types of

intervening variables, teacher's and pupils. As mentioned in the caption 3.4.0 the age, sex, experience and qualifications of the teachers were kept similar to decrease the effect of these intervening variables. (Personality and other things were not considered here as it is out of one's hand). As far as intervening variables relating to pupils are concerned, I.Q. and pre-achievement of pupils' in the subject of science were considered to be intervening variables. These were statistically controlled through the use of analysis of covariance as shall be discussed in caption 3.8.0.

3.4.0 Sample

The experiment required the sampling of pupils, teachers and units of teaching. The selection of pupils', teachers and units of teaching is detailed below.

Pupils :

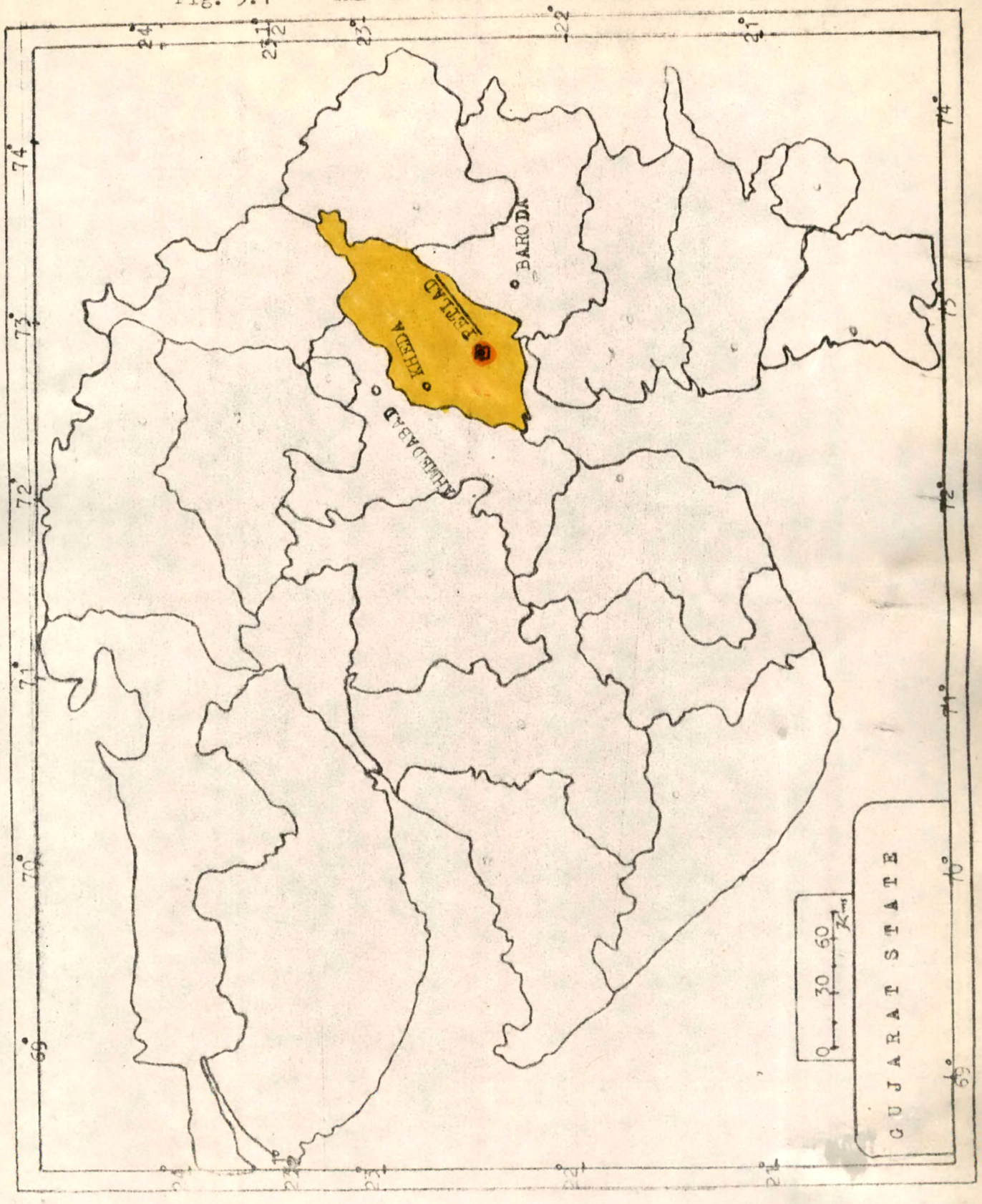
Before taking a decision about pupils it was essential to select a school where the experiment could be conducted. The school was to be selected keeping in mind -

1. The willing cooperation of the head of the institution.
2. The willing cooperation of the members of staff.
3. The strength of pupils.
4. The adequate sitting facilities

5. The socio-economic status of the pupils.
6. The extent of the completion of the syllabus in the subject of science, and
7. The timings of the school.

In Petlad (Figure 1) provides the location of the Petlad town), there are five secondary schools which have primary sections (i.e. Stds. V, VI and VII) attached to them. Out of these schools only two have the two divisions of standard VIIth. The investigator selected New Education School for the purpose of experiment as the institution fulfilled the criteria stated above. The secondary school was selected keeping in mind the competence of the teachers and other facilities required. There were reasons for conducting the experiment in one school. This would control extraneous variables that might come into play due to the inter-school differences in the class-room atmosphere. The school in the sample was private school requiring the pupils to pay the fees. The school selected was co-educational one. Selecting the above said school alone for experiment might have put limitation to generalisability of results of the experiment, since the sample - subjects seemed to have come from the middle and upper socio-economic group. But judging from the achievement of the students of their terminal examination on general science, they were found to be almost

Fig. 3.1 THE LOCATION OF PETLAD TOWN



normally distributed. Hence, it was thought that selecting one school would be better than sampling from different schools, inviting more serious differentiating influence of the school environment, on the treatment variables.

As stated in chapter I (caption 1.2.0) the primary school level viz. standard VII the terminal year in the primary section, was selected as it was felt to have enough matured pupils who would respond to the teaching, planned for the development of creative thinking. (An objective higher than the knowledge objective)

All pupils of seventh class of the school who by and large had been studying in this very school right from the beginning were involved in the experiment. Seventh class had only two sections viz. VII A and VII B with the strength of 49 and 48 pupils respectively. For the requirement of four groups in the experiment, the investigator equally divided these two sections into four groups viz. Group I, Group II, Group III and Group IV. Data about the number of pupils in each group and those who were present throughout the experiment is given in Table 3.4 on the next page.

As is clear from Table 3.4 strength of Group I, Group II, Group III and Group IV was 24, 25, 24, 24 respectively.

Table :3.4: Distribution of the Pupils' Sample

Groups	Total Pupils	Present throughout	Final Selection
I	24	20	20
II	25	22	20
III	24	21	20
IV	24	20	20

Considering only those pupils who attended all the teaching and testing sessions, the strength of Group I to Group IV remained at 20, 22, 21 and 20 respectively. The simpler analysis of the design required equal number of cases in each cell (Walker and Lev 1953). Since 20 was the maximum number in two groups that is Group I and Group IV, the investigator made random selection of 20 cases from the other two groups i.e. Group II and Group III. Thus, the total sample of the pupils for the final analysis remained 80. Means and SDS for I.Q. age and creative thinking of the sample present throughout the experiment were obtained and they are given in Table 3.5 below :

Table :3.5: Representation of Means and SDS for I.Q., Age and Creative Thinking of The Sample present Throughout the Experiment

Sr.No.	Variables	N	Mean	SDs
1	I.Q.	80	82.28	16.48
2	Age	80	12.5	1.04
3	Creative Thinking	80	72.72	21.08

As is evident from the above Table 3.5 mean and SDs for I.Q. of the pupils present throughout the experiment were 82.28 and 16.48 respectively. Mean and SDs of the age of the sample were 12.5 and 1.04 respectively. Means and SDs of the creative thinking of the sample were 72.72 and 21.08 respectively.

(ii) Teachers :

(A) Selection : Since the teachers were the only agents to provide treatment in the classroom units, selection and special training of the teachers were important. In order to control the influence of inter-teacher variations, it was planned to have teachers, having maximum homogeneity in relation to some important related teacher variations. Since it was not possible to conduct such an extensive study with

the help of one teacher alone, which could have controlled otherwise the inter teacher variations, a compromise was made to extend the number of teachers to four, to fit in the 4 X 4 Latin Square Design. The experiment involved such teachers who had a good knowledge of the content to teach, who could be programmed, and who could decide and change strategies of teaching as required by the design, without any previous bias.

In order to choose four teachers the investigator contacted a group of his B.Ed. students. He told them about research in education in general and research in the area of teaching for developing creative thinking in particular. He made them aware about its important contribution in improving education in its various facets. He told them that he himself too was doing research and topic was 'The experimental investigation of the effects of selected teaching strategies upon the development of creative thinking and achievement in science.' He also gave them the outline of the study, oriented them with the programme, aroused in them interest in the same and their cooperation was sought. Out of this group of twenty two student teachers, almost all of them showed interest and a willingness to participate in the experiment. Finally six teachers were selected. It had to be

made certain that the teachers were in a position to vary the treatment as per the requirements of the design. These teachers belonged to the age group 22 - 23 years, all were untrained science graduates. Their subjects at degree level were chemistry - physics and they had same training and teaching experience at school.

(B) Programme of Training : The selected student teachers were thoroughly oriented with the four strategies of teaching, units of teaching, the lesson plans based thereon and with the objectives of study. Details regarding the selection of the teaching units and preparation of lesson plans will follow in this chapter. Units of teaching were intensively read and discussed with the experimental teachers and an insight was developed in content. The investigator gave demonstration lessons using the four strategies of teaching to experimental teachers on four successive days. Everyday after demonstration discussion were held,doubts were removed and querries were answered.

Then the experimental teachers practised different strategies of teaching, first in stimulated situations and then in real classroom situations, under the supervision of the investigator and his colleagues. Practice in simulation situation was done for eight days, (two days for each strategy). The supervised lessons were discussed and

consequent improvements to master the teaching strategies were taken care of. After sufficient practice in the simulated condition, various teaching strategies were tried out on pupils of seventh standard, belonging to groups other than those selected for the experiment. These lessons, in real situations, were also supervised and critically discussed by the colleagues of the investigator. All observers had good knowledge of methods and contents as they were method masters in education college. The teachers embarked on the actual experimentation only after the observers gave a clear signal that the teachers could successfully change the treatment delivery in successive class periods.

Finally, out of these six teachers the investigator randomly selected four for the purpose of thee experiment. The remaining teachers served as stand-by. However, in the course of the experiment no help of the stand-by teachers was taken as the selected teachers were present throughout the experiment.

(iii) Units :

(A) Subject : Before selecting units it was necessary to choose subject. The subject of science was selected for the purpose of the experiment, as the investigator is a graduate in science and the investigator had experience of teaching science for several years in school as a science teacher, as

well as in education college as a method master of science, and there were all possibilities to handle the subject properly.

(B) Units : Since, the purpose of the present study was to compare the effectiveness of the different teaching strategies (on the development of creative thinking and achievement), the teaching units were meant to serve as mere carriers for them. Hence there was no necessity of selecting special types of units. It might not be feasible also, in such an extensive study. So the units of teaching were selected from the science textbook prescribed by the Gujarat Government for the seventh class pupils of the State. All the four units were formed from remaining syllabus for that period. The Units of teaching were selected from prescribed text book because, that way the experiment would be conducted in a natural setting and that the time of students would not be wasted during the course of experiment. It was also thought that the pupils would take more interest in the content as it was from their own course book.

Unit I : 'Magnetism and static electricity',
Unit II : 'Current electricity... '
Unit III : 'Properties of acid, base, metal', and
Unit IV : 'Universe and gravitation... '

3.5.0 Treatment

The teaching of selected units according to the four teaching strategies chosen for the experiment formed the treatment. To

professor. Sample lesson plans, for each strategies, have been given in Appendix - D.

3.6.0 Instrumentation

In experimental studies, two kinds of informations are needed. First, the description of the nature of the sample, and the measures for the development of new abilities in the sample as a result of treatment variables. For collecting these informations, there is a need of good instruments, and all researchers look for the best tools available.

In the present study too, the tools were used with two purposes in mind. The first purpose was to describe the nature of the sample, and for this three tools were used viz., (i) Intelligence Test (ii) Creative Thinking Test and (iii) Achievement Test. As a result of the treatment variable, there would be some difference in the creative thinking and achievement of the pupils under treatment. The second purpose was to measure this difference. This purpose was served by the use of two kinds of tools (i) Battery of Creative Thinking Tests and (ii) Criterion Attainment Tests, both developed by the investigator himself.

The details regarding the selection of tools and description of tools are given as follows :

3.6.1 Tools for the Description of the Sample :

Three kinds of tests were used for describing the nature of the sample. (i) Intelligence Test (ii) Creative Thinking Test (iii) Achievement Test. The details of each test are given in the following captions.

3.6.1.1 The Bhatt's Group Test of Intelligence : The I.Q. scores of the pupils were obtained by administering the Champaben Bhatt's Group Test. It is a standardised group test of intelligence for Gujarati pupils of Standards V, VI and VII, suitable to the exigencies of the urban, semiurban and rural cultures. The test consisted of matching legs of tables (non-verbal), matching professions and things (verbal), analogies (non-verbal), classification (non-verbal), pictorial absurdities (non-verbal). The test contains 139 items and the time required to answer it, was fixed at thirtyfive minutes. The items are arranged in the ascending order of their difficulty values. It was standardised on a sample of 5173 boys and 4649 girls drawn from 58 schools, representing urban, semiurban and rural areas of Gujarat.

The reliability coefficients of the test computed by K.R. formula 20, split-half method, Gutman's formula and Rulon's formula were 0.93, 0.91, 0.97 and 0.98 respectively. The congruent validity of the battery was estimated by correlating the I.Qs. on the present test with those obtained on the other

intelligence tests. The correlation of this test with the Desai's Group Test of Intelligence was 0.88, with Shukla's adaptation of Stanford-Binnet Intelligence 0.82, and with Joshi's Group Test of General Mental Ability 0.68. This test is easily available in the market with scoring key.

3.6.1.2 The Creative Thinking Test : The Torrance Tests of Creative Thinking (T.T.C.T. Figural version - A) was the second standardized tool used in this study for measuring the creative thinking of the sample. The T.T.C.T. were employed all over the world to assess the various dimensions of creative thinking in many studies relating creativity. The tasks of T.T.C.T. are also kept open ended, so that respondents be able to respond in terms of the experiences gained by them. This is the true nature of divergent production and it has been responsible for fairly consistent finding that the T.T.C.T. has little or no racial, ethnic or S.E.S. bias (Torrance 1971) and that it has a significant degree of validity even in the countries other than U.S.A. (Ogletree 1971). Reviews of Raina (1971-72) show that even in India it has been used fruitfully on a wide range. T.T.C.T. have been widely used in researches and they are translated into many languages like Hindi, Gujarati, Urdu, Chinese, Japanese, Korean, French, German, Italian, Spanish etc.

The investigator used T.T.C.T. figural version - A in Gujarati. It is appropriate for use in kindergarten through graduate level. There are three sub-tests in the figural version viz. (i) Picture Construction (ii) Picture Completion (iii) Parallel Lines. Scoring was made for fluency, flexibility, and originality, i.e. three components of the creative thinking.

3.6.1.3 Achievement Test : For knowing the previous achievement of the sample, an achievement test was administered. Though the result of the examination which immediately preceded the start of the experiment, was available, the investigator thought it proper to assess the achievement scores by administering his own achievement test so as to avoid the possibility of any kind of bias. In the development of test, content which pupils have already learnt, was selected. The style of the test was kept traditional one with which the pupils were familiar. So all the three types of questions viz., essay type, short answer type and objective type, were included in the test. Regarding weightage for : objectives, type of questions, and units, a blue print was prepared with the help of competent science teachers from the school and college. It was a teacher made test and the purpose was to know the achievement of particular sample. So no rigorous steps were followed which are normally applied while

standardising the test. The investigator remained satisfied only with the opinion of experts.

3.6.2. Tools for Measuring the Effect of Treatment Variables :

Two kinds of tools were used for measuring the effects of treatment variables (i) Batteries of creative thinking tests were used for measuring the development of creative thinking and (ii) Criterion attainment tests were used for measuring the achievement of the pupils, that might have accrued as a result of treatments.

Summary of the tests are given in the captions to follow.

3.6.2.1. Batteries of Creative Thinking Tests : Those who decide to use the tests of creative thinking emphasize that the tests should measure the talent which is different from the mental ability and the trait measured by the conventional tests. So before a test can be accepted as measuring a distinct creative ability, one should remember that (i) to some degree it must be independent from the conventional tests of general ability and (ii) it must be shown that pupils acquiring high scores on such tests should be in a position to produce original works of some kind that

are excellent for their age and training. Considering these views the batteries for creative thinking tests were constructed by the investigator himself and administered on the experimental subjects. It consists of verbal tests of creative thinking developed in Gujarati. Each test battery includes three sub-tests namely (i) The Unusual Uses Tests (ii) The Consequences Tests (iii) The Seeing Problem Tests. These tests are classified on the lines of Torrance (1962) as Test consisting of verbal tasks namely the unusual uses tests, The consequences tests and the seeing problem tests. The tests can be administered to a group at a time.

The nature of the tests permitted freedom of responses both qualitative and quantitative within specified time limits. Thus, it can be seen that these tests do satisfy the necessary prerequisites of the divergent thinking test. Instructions and practice items were given orally before the administration of the different tests. The respondents are supposed to write their responses in a particular space provided in the test papers. A brief and specific outline of the three tests employed in all the four tests batteries of the study is given in the following captions.

3.6.2.1 The Unusual Uses Tests : Guilford (1962) who originated this type of test says that the child should be in a position to give as many different uses of any common place

object e.g. 'brick'. The present tests developed by the investigator is on the lines of Guilford test. It is i a verbal test. This test includes only those items which have proximity with psychological and physical environment of the subjects. The tasks are obviously enjoyable and can be expected to hold the interest of the respondents. In each battery, the tests of unusual uses includes two items like, Dry-Cell, Bamboo, Water etc. The test measures the dimension of fluency, flexibility and originality. The subjects were instructed to write down as many interesting and unusual responses as they can to each stimulus article. The maximum time limit for the task was kept ten minutes. So that five minutes could be devoted to each item. All the necessary instructions were given orally at the time of administration.

3.6.2.2 The Consequences Test : It is a verbal and group administered test. The pattern of the test is based on the tests of Guilford et al (1962) and Torrance (1962). The test measures the dimensions of fluency, flexibility and originality. In each test battery there are two items for this test e.g. 'If the sun sets for ever', 'If there were no gravitation...', 'If pupils were not to study...' etc. The maximum time limit for the test was keptt ten minutes so that five minutes could be devoted to each item.

Respondents were instructed to write down their thoughts and imaginations in a novel way. All other necessary instructions were given orally at the time of administration.

3.6.2.3 The Seeing Problems Tests : It is also a verbal and group test. This test was also developed by adopting the pattern of Guilford et al (1962). It is designed to measure a factor of sensitivity to problems which is a component dimension of creative thinking as described by Guilford. The tests are proposed to measure the ability to comprehend problems concerning the working of simple and handy articles. In all four batteries there is one item for seeing problem test namely radio, bicycle, compass and benches. The respondents are expected to write the defects and problems in using each of these articles. The maximum time limits for test was kept five minutes. All other necessary instructions were given orally at the time of administration.

3.6.2.4 Scoring : The style of the tests and situations provided in each battery of the tests are common, just like any other creative thinking tests. There is nothing new. It can be used for any culture in any situation. What is important is the scoring for the tests. The respondent's responses may differ from culture to culture, but researcher can prepare the particular list of the responses which do not affect the scoring

procedure. If the scoring is to make valid relating creative thinking, separate system of scoring might be devised with the help of a panel of judges, in each culture, who can recognise creativity, when they see it. A researcher can ask them to give opinions about the relevance and categorization of responses to different items of tests, wherever and whenever necessary. This is not a problem with students in the elementary grades. For elementary grades, the researcher himself may analyse the relevance and categorization of responses, in conflicts, discussion with judges may be held in order to take the final decision. The last procedure has been adopted in this study. For the present study the scoring system as envisaged by Torrance was adopted.

With all tests, the dimensions of fluency, flexibility and originality were measured. The score for fluency is obtained by counting the total number of acceptable responses for particular test. Flexibility is represented by the number of different categories, according the nature of responses. For originality scores, it was not considered to assign weightage to a response according to its level of commoners, the greater the fluency of occurence of particular response in group the more is the commoners and lower is scores of the originality and vice-versa. In short all the scoring for these

tests was done on the line of Torrance.

A pilot administration, along with T.T.C.T. (Figural) was conducted on a stratified sample, with a view to preparing scoring key and establishing reliability and validity, for all the test batteries. Items of each battery for the pilot study were selected after proper screening with the help of experts. Thus, selected items, were revised and improved according to the suggestions of experts. Then pre-pilot administration was conducted on a randomly selected sample. The time limit and plausibility ofe each item was decided from the pre-pilot administration.

The method of Inter-scorer reliability was adopted. All the tests were first scored by the investigator himself. Then out of them randomly selected tests were scored by a person trained for job. The reliability coefficients obtained are 0.94 for fluency, 0.91 for flexibility and 0.88 for originality.

Concurrent validity was established against the T.T.C.T. (Figural version - A). It was determined by computing the product-moment coefficient of correlation between the scores obtained by the pupils on the two measures i.e. the present tests and the T.T.C.T tests. The validity coefficients obtained are 0.87, for fluency, 0.79 for flexibility, 0.74 for originality and 0.81 for total creativity scores.

As the test batteries evolved by the investigator has limited use, he refrained himself from using the other sophisticated techniques for standardization.

3.6.2.5 Criterion Attainment Tests : There was no standardised test available that could be used as a criterion attainment test in the present study. Hence criterion attainment tests were developed by the investigator on the four selected units, one test for each unit, keeping in the mind, the objectives of knowledge, application and skill. Criterion attainment test I (At_1) was developed on Magnetism and Static Electricity, test II (At_2) was developed on current electricity, test III (At_3) was on

properties of acid, and metal, and test IV (At_4) was on Universe and gravitation. The final tests are given in Appendix E. It was seen that the types of items, selected were essay type questions, scientific problems, reasons, and drawing the figures. Marks were assigned for each item, in accordance with the relative importance of the expected terminal behavior. The preliminary drafts of all the four tests were administered on the pupils other than experimental one of VIIth class in the school. It was made sure that the content related to all tests had been taught to the pupils by the science teachers in the school. In consultation with some science teachers, the time of thirty minutes for each test was considered adequate.

These were the teacher made tests and were developed to satisfy the requirements of the experiment. Hence all the sophisticated steps were not taken to standardise the tests. Competent science teachers confirmed the objectives, content validity and difficulty indices of the items selected for the tests.

3.7.0 Procedure of the Experiment

The IQ test, Creative Thinking Test and Achievement Test were administered to the pupils selected for the experiment, to know and describe the nature of sample. The four groups of the sample were subjected to the treatment as per design of the study described in this chapter under caption 3.1.0. After teaching ten lessons, which comprised a unit, the corresponding criterion attainment tests and creative thinking tests, under planned testing conditions, were administered, with a prior announcement of the same. This scheme of teaching and testing was followed for all the four sessions of the experiment. One day, after the completion of all the four sessions of the experiment, again I.Q. and Creative Thinking Tests were administered to the subjects. A schematic presentation of the procedure followed in the experiment is given in Table 3.7 on the next page.

Table :3.7: Schematic Presentation of the Procedure followed in the Experiment

The I.Q.Test, Creative Thinking Test (T.T.C.T.) and Achievement Test administered to all pupils

SESSION I

Days	Group I	Group II	Group III	Group IV
First day	Unit I Teacher I Strategy I Lesson 1	Unit II Teacher II Strategy I Lesson 1	Unit III Teacher III Strategy I Lesson 1	Unit IV Teacher IV Strategy I Lesson 1
Second day	Unit I Teacher I Strategy I Lesson 2	Unit II Teacher II Strategy I Lesson 2	Unit III Teacher III Strategy I Lesson 2	Unit IV Teacher IV Strategy I Lesson 2
Third day	Unit I Teacher I Strategy I Lesson 3	Unit II Teacher II Strategy I Lesson 3	Unit III Teacher III Strategy I Lesson 3	Unit IV Teacher IV Strategy I Lesson 3
	.	.	.	.
	.	.	.	.
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	.	.	.	.
Tenth day	Unit I Teacher I Strategy I Lesson-10	Unit II Teacher II Strategy I Lesson-10	Unit III Teacher III Strategy I Lesson-10	Unit IV Teacher IV Strategy I Lesson-10
Eleventh day	$*AT_1$ $*CT_1$	$*AT_2$ $*CT_2$	$*AT_3$ $*CT_3$	$*AT_4$ $*CT_4$

* AT = Achievement Test
* CT = Creativity Test

(Continued...)

SECTION II

Days	Group I	Group II	Group III	Group IV
First day	Unit II Teacher II StrategyII Lesson 1	Unit III Teacher III Strategy II Lesson 1	Unit IV Teacher IV Strategy II Lesson 1	Unit I Teacher I Strategy II Lesson 1
Second day	Unit II Teacher II Strategy II Lesson 2	Unit III Teacher III Strategy II Lesson 2	Unit IV Teacher IV Strategy II Lesson 2	Unit I Teacher I Strategy II Lesson 2
Third day	Unit II Teacher II Strategy II Lesson 3	Unit III Teacher III Strategy II Lesson 3	Unit IV Teacher IV Strategy II Lesson 3	Unit I Teacher I Strategy II Lesson 3
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Tenth day	Unit II Teacher II Strategy II Lesson-10	Unit III Teacher III Strategy II Lesson-10	Unit IV Teacher IV Strategy II Lesson-10	Unit I Teacher I Strategy II Lesson-1
Eleventh day	$*At_2$	$*At_3$	$*At_4$	$*At_1$
	$*CT_2$	$*CT_3$	$*CT_4$	$*CT_1$

(Continued...)

SESSION III

Days	Group I	Group II	Group III	Group IV
First day	Unit III Teacher III Strategy III Lesson 1	Unit IV Teacher IV Strategy III Lesson 1	Unit I Teacher I Strategy III Lesson 1	Unit II Teacher II Strategy III Lesson 1
Second day	Unit III Teacher III Strategy III Lesson 2	Unit IV Teacher IV Strategy III Lesson 2	Unit I Teacher I Strategy III Lesson 2	Unit II Teacher II Strategy III Lesson 2
Third day	Unit III Teacher III Strategy III Lesson 3	Unit IV Teacher IV Strategy III Lesson 3	Unit I Teacher I Strategy III Lesson 3	Unit IV Teacher II Strategy III Lesson 3
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Tenth day	Unit III Teacher III Strategy III Lesson 10	Unit IV Teacher IV Strategy III Lesson 10	Unit I Teacher I Strategy III Lesson 10	Unit IV Teacher II Strategy III Lesson 10
Eleventh day	*AT_3 *CT_3	*AT_4 *CT_4	*AT_1 *CT_1	*AT_2 *CT_2

(Continued...)

SESSION IV

Days	Group I	Group II	Group III	Group IV
First day	Unit IV Teacher IV Strategy IV Lesson-1	Unit I Teacher I Strategy IV Lesson-1	Unit II Teacher II Strategy IV Lesson-1	Unit III Teacher III Strategy IV Lesson-1
Second day	Unit IV Teacher IV Strategy IV Lesson 2	Unit I Teacher I Strategy IV Lesson 2	Unit II Teacher II Strategy IV Lesson 2	Unit III Teacher III Strategy IV Lesson-2
Third day	Unit IV Teacher IV Strategy IV Lesson 3	Unit I Teacher I Strategy IV Lesson 3	Unit II Teacher II Strategy IV Lesson 3	Unit III Teacher III Strategy IV Lesson 3
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Tenth day	Unit IV Teacher IV Strategy IV Lesson 10	Unit I Teacher I Strategy IV Lesson 10	Unit II Teacher II Strategy IV Lesson 10	Unit III Teacher III Strategy IV Lesson 10
Eleventh day	*AT_4 *CT_4	*AT_1 *CT_1	*AT_2 *CT_2	*AT_3 *CT_3

The I.Q. Test and Creative Thinking Test (T.T.C.T.) administered to all pupils.

* AT_1	Achievement Test 1	CT_1	Creative Thinking Test 1
AT_2	Achievement Test 2	CT_2	Creative Thinking Test 2
AT_3	Achievement Test 3	CT_3	Creative Thinking Test 3
AT_4	Achievement Test 4	CT_4	Creative Thinking Test 4

3.8.0 Statistical Techniques

The data were analysed by applying various statistical techniques :

(i) Mean and SDs were worked out for the variable of I.Q., age, and creative thinking for the purpose of describing the sample.

(ii) The data obtained through the Latin Square Design were analysed by applying ANOVA on the lines of Winer (1962). This was worked out to see the effects of strategies of teaching upon pupils achievement and development of creative thinking in terms of fluency, flexibility, originality and total creative thinking scores.

(iii) In order to pin point the significance of difference between mean scores a L.S.D. test (Least significance Difference test) i.e. extension of 't' test was applied. This was done for the variables of Achievement, Fluency, Flexibility, Originality and Total Creative Thinking.

The entire analysis was done by the investigator himself with the aid of a pocket calculator.