.."And research does seem to warrant the postulate

that the gap between an individual's innate creative talent

and his lesser creative output can be narrowed by
deliberate education in creative thinking.

- Sidney J. Parnes

CONTENTS

3.1 Purview
3.2 Layout of Related Researches: Abroad
3.3 Research Studies on Creativity: India
3.4 Rationale of the present study
It would be better to have a bird's eye view of the history of the development in creativity along with some details about the tests and programmes applied in creativity. This would provide a historical background of creativity as a whole and would also make it clear for the investigator to foresee the limitations and scope of the study and to locate the research problem in the whole area of investigation. It also helps in selecting the proper tools, sample and treatment or analysis of data. Moreover it helps to practise the conclusions of the research and to avoid ambiguities. It enables the research worker to find out related problems for further study. Consequently, it has been attempted for a look back about the related literature akin to the present study.

3.1 Purview

The systematic historical study of researches in creativity is made as follows:

(a) Creativity and its measurement.

This includes the trends and status of testing in creativity, problems in measurement of creativity thinking and their users.
(b) Creativity and Personality

It is related to personality of a creative child, creativity and personality, growth and trends of creativity components personal variables and second order personality correlates of creativity. Creativity is related to the values of the Indian adolescent students.

(c) Creativity and Intelligence

Different researches like creativity as related to intelligence, a study of creative thinking with special reference to intelligence, creativity and its components as affected by intelligence and relationship of intelligence and fluency among students are included in this field.

(d) Creativity and Education

It gives the review of different researches like education, teachers creativity and family background - a study of relationship, creativity and academic achievement among secondary school children, creativity as related to achievement, motivation and birth order.

(e) Researches on Creativity Training

This is a branch of research field in creativity which is most important and yet a few researches have been completed. Some well-known researches are listed here e.g. special programmes
for developing creativity, techniques for development of creativity, creative problem solving and divergent thinking, transcendental meditation etc.

From these classifications some researches related to the last one will be discussed here into two categories as under:

3.2 Lay out Related Researches : Abroad

Good amount of work in this area has been done in foreign countries, especially in U.S.A. Research study related to this investigation is reviewed below:

3.2.1 Study 1

A programme for the development of thinking skills. 1

This Productive Thinking Programme (PTP) is developed by Covington, Crutchfield and Davis in 1966 at the University of California. This set of booklet materials, designed primarily for Vth and VIth grade students, provides systematic instruction and carefully guided practice in the skills of productive thinking and problem solving. 16 programmed booklets are individually self administered and self paced each requiring approximately one hour.

Each lesson is so designed that as the student works through the problem, he is led eventually to discover the solution for himself, this giving him the thrill of discovery and helping him develop a sense of confidence in his ability to cope with difficult and challenging intellectual tasks.

A total of 280 students, comprising five Vth grade and five VIth grade classes, participated in this study. Those were generally above average in intellectual ability. The mean I.Q. of the group was 115 checked on 6 sub-tests of the Stanford Achievement Battery. In order to equate these two grades for the influence of a particular teacher and a particular classroom climate, a split class technique was used. Half the students of each class were selected to receive instruction in productive thinking, while the other half of each class served as a non-instructed control group.

Both the groups were given a pre-test battery of productive thinking problems to determine the extent to which any difference in productive thinking proficiency existed before instruction began. Then during the next 8 weeks the instruction group devoted approximately one hour per day to instructions in productive thinking. While the control group spent the same daily hour in activities programme consisting of stories, movies and various projects chosen to interest the
children and to have general educational value, but not to relate to productive thinking. At the end of 8 week period, performance of the two groups was compared on an extensive post test battery of thinking problems.

These studies have consistently been found to produce significant gains in student performance on a variety of tests of productive thinking. The trained students have demonstrated strengthened skills in cognitive functions as generating ideas of high quality, asking relevant questions, being sensible to crucial clues, making effective use of informations and achieving solutions to problems.

At various points in the booklet lesson, the student practices using such skills and writes down his ideas, questions or suggestions for what should be done next. The student is led to understand what constitute relevant and original ideas, how to proceed fruitfully when faced with a challenging problems and what effective strategies to use when encounters difficulties.

Results

1. Performances of the instruction and control groups were nearly identical on the pre-test battery, indicating that they were well matched in productive thinking proficiency before instruction began. Indeed the small
difference that did exist favoured the control group.

2. After the instructional programmes had been computed, a clear and substantial superiority in thinking was shown by the instruction group.

3. On the follow up battery, performance of the instruction group continued to surpass that of the control group by significant margin. Thus the gain in thinking skills produced by the 8 weeks of instructions was still evident more than 6 months after instructions had ended.

The same study has been replicated by Olton and Wardrop in 1967.

3.2.2 Study-2

Development of Purdue Creative Thinking Programme (PCTP)$^2$

This programme is prepared by Carington Cruthfield and Feldhusen in Purdue University. The programme was first prepared in 1970 and was finally revised in 1981. The review will be studied with respect to the description of the

2. J.F. Feldhusen, Purdue Creative Thinking Programme, (West Lafayette: Purdue University, Gifted Education Resource Institute, 1981).
procedure and goals to provide directions for efforts. Finally results and research findings will be discussed.

Description

The Purdue Creative Thinking Programme (PCTP) consists of 32 audio taped programmes on 8 pages, and a set of 3 to 4 printed exercises for each programme. The taped programme consists of two parts: (i) a 3 to 4 minutes presentation designed to teach a principle or idea to improve creative thinking, (ii) 8 to 10 minutes story about a famous American Pioneer. The exercises for each programme consists of printed directions, problems or questions which are designed to provide practice in fluency, flexibility originality and elaboration in thinking subject matter and teaching strategy.

The content of the audio-tapes focuses on social studies. The series also teaches writing and listening skills which are related to the language arts. The programme is designed to be administered in a group setting or individual learning.

In developing the series some goals to provide directions for efforts were formulated as under:

1. Focus on famous people and events that represent models of creative activity.
2. Present information as a vehicle and stimulus for creative thinking.

3. Teach creative thinking and problem solving.

4. Involve students in creative verbal and drawing activities.

5. Use auditory rather than visual stimuli to encourage imagination.

6. Undertake a substantive programme of research and formative and summative evaluation.

A typical format is to present one programme each week and to devote about 45 minutes to the tape and activities. After a brief introduction by the teacher, the children can discuss what they know about the person featured in the programme. This motivates the children to listen carefully. The tape is played for about 15 minutes. Activity sheets are then distributed and discussed briefly to make sure that the children understand the instructions.

Some exercise stresses verbal fluency, flexibility and originality and others are strengthened by non-verbal exercises. Figural activities stress elaboration along with above 3 factors.
Results and Evaluation

There are at least 15 published reports summarising research and evaluation on PCTF. The most recent is an extensive review of Clinkenbeard in 1980. It can be summarised briefly as under:

One of the first major studies showed that children who had experienced the programme scored higher than controlled ones on verbal and figural originality, verbal fluency, non-verbal elaboration and language skills. A subsequent project showed increasing fluency and originality especially at the fourth grade level, for children who had been through the programme. It was also found that activities were the most effective parts of the programme, stories almost as effective and introductory presentation somewhat less effective.

In another study teacher effects were investigated in the context of a comparison of the PCTF and FTP. Both were found effective in producing creative thinking gains but the FTP produced slightly more consistent gains. It became evident that children make greater gains when teacher refrain from extensive discussion of the stories.

Some scientists carried out further tests, regarding the effects of spaced is massed programme use on problem
solving skills, again comparing the PTP with PCTP. They found both the programmes effective in developing divergent thinking abilities and determined that the teacher's leadership role can facilitate greater creative growth when programmes are used over a longer rather than massed period of time. Overall it seems that one may conclude optimisti-
cally that the PCTP is effective in developing creative thinking abilities and some related attitudes and skills.

Teachers too can learn a great deal about creative teaching from the introductions to the tapes. The pro-
gramme has at best, limited effectiveness though, like other creativity thinking programmes it is perceived as a valuable and enjoyable experience for teachers and students alike.

3.2.3 Study 3

This study was done by John Feldhusan and Fred Widlak at the University of Brazilia.³

In the present study 14 out of 28 stories of the PCTP and the corresponding exercises were used with a sample of children in Brazil. The choice of 14 dramatises stories

was based on their relationship to the programme of history and social studies in Brazilian schools. The programmes were translated into Portuguese by the first author.

Sample

A total of 576 fourth and fifth grade children from 24 classes in both private and public elementary schools in Brasilia, Brazil participated in the study. There were 12 fourth grade and 12 fifth grade classes with 8 classes assigned to each of two treatment conditions (Programme with reinforcement of the pupils' performance on the creativity exercises and programme without reinforcement of the pupils' performance on the creativity exercises) and 8 classes assigned to the control group condition.

Procedure

Before instruction began two verbal sub-tests (unusual uses and product improvement) and two figural sub-tests (circles and picture completion) of the Torrance Test of Creative Thinking (TTCT) were administered as per tests to all pupils in both the experimental and control groups. The tests were translated into Portuguese. The instructional material was then administered to the experimental groups by the teacher once a week for 14 consecutive weeks. The teachers were taught how to use the material. In administering the programme the teacher read the introduction and the
story to the children since tape players were not available. The pupils then worked on the printed exercises. In one experimental condition (programme with reinforcement) the children's completed exercises were evaluated by the experimenter. She wrote encouraging comments on their papers intended to reinforce fluency and elaboration (e.g. very good, good, good but try harder, try harder) and then gave back to the children. Pupils in the other experimental condition received no reinforcement. Pupils in the control group received no creativity training. At the end of 20 weeks TTCT form A was administered as post-test to all pupils of the project.

A 3x2x2 (treatment by sex by grade level) analysis of covariance was used to analyse pupil performance on each of the 12 creative measures. Previous research indicated that the creativity sub-tests were task specific and should be analysed separately. The covariates for the divergent thinking measures were the respective TTCT pre-test measures. Post hoc individual comparisons between adjusted means were made for significant effects using the Newman-Keuls Procedures. Further analysis of covariances were carried out to analyse the effect of treatment using the class as the sampling unit.

Results

Using individual subject as the sampling unit, a consistent finding across all dependent variables was that no
Interaction effect reached statistical significance. The main effect of treatment was significant for all three creativity dimension of fluency, flexibility and originality for the lines and unusual uses sub-tests. Here the treatment effect was also significant for figural originality on the product improvement sub-test. The effect of classes within treatments was significant for figural fluency on the lines and picture completion sub-tests, for figural flexibility on the lines subtest, and for verbal originality on the unusual uses sub-test. The significant classes within treatments effect indicates differences among the classes in the effectiveness of the programme. In India this study is being replicated by J.Z. Patel at M.B. Patel College of Education, Sardar Patel University, Vallabh Vidyanagar as the project is financed by U.G.C.

3.3 Research Studies on Creativity : India

Since few years ago some researches on creativity training have been carried out in different parts of India.

3.3.1 Study-4

This study has been carried out by Jarial in 1981. 4

Both the forms of the programme (verbal and non-verbal) included 25 lessons each. Each lesson comprised 2–6 items. The items pertaining to the verbal form of programme has the content from the immediate environments of the students i.e. home and school and the non-verbal form of programme utilised the geometrical figures, such as points, triangles, squares etc., and sketches as its content. The experimental part of the study followed a pre-test post-test experimental control group design. The group undergoing treatment in verbal form of the programme consisted of 80 students who were divided into two comparable (on the basis of I.Q. scores and the scores on the components of verbal creativity) groups—experimental and control. The students of the experimental group were given treatment in verbal instructional materials, whereas no treatment was given to the students of control group. The non-verbal treatment group also consisted of 80 students who were divided into two comparable groups (on the basis of I.Q. score and on the components of non-verbal creativity). One of these groups was named as the experimental group and the other was termed as the control group. Like the verbal treatment group, here too the students of the experimental group were given treatment in non-verbal instructional materials, whereas no treatment was given to the students of the control group.
The treatment given to the students of both experimental groups continued for 50 days utilising one period per day of 35 minutes duration. On one set of alternate days the students were administered the lessons from the instructional materials, and on the other set of alternate days, discussion around the already completed lessons was done. The TTCT, Form A (verbal and figural) were administered to the students of the respective groups at present stage, and their parallel tests (TTCT Form B) were administered to the similar students at post-test stage. The results showed a significant effectiveness of the programme in developing different components of verbal creativity and various components of non-verbal creativity of the student. The development of the various components of verbal creativity, as a result of training in the programme, was observed to be independent of the effect of sex, socio-economic status, and initial creativity levels. The development of the different components of non-verbal creativity was not influenced by the variation in socio-economic status of the students. The sex and initial creativity levels did not seem to effect the development of different components of students' non-verbal creativity, except elaboration, with respect to which the female students and the students of initially low creativity levels gained signed significantly higher than male students and the students of initially high creativity levels respectively.
3.3.2 Study 5

"A study of the Effectiveness of Verbal Creativity Instructional Materials at school stage". S. Bhaaskar has undertaken for his doctoral work.

The sample comprised 51+36 students of Std. VI of 15 schools of Bangalore district. The 15 schools 5 in each of 3 educational district were selected. Single group pre-test post-test design was selected.

Procedure

Passi tests of creativity comprise six tests, 3 verbal, 2 non-verbal and 1 with non-verbal stimuli but verbal responses. Four of the tests, 3 verbal tests and one with non-verbal stimuli with verbal responses were selected as the instructional materials that would be developed would only be in verbal form. The four tests viz., seeing problem test, unusual uses test, consequences test and test of Inquisitiveness, were translated into local language Kanuada. As the children of Std. VI would not be fluent and fast in writing as their counterparts in secondary, higher secondary schools, the time per test was increased to 1½ times. The tests with increased

---

time duration were administered by the investigator in all the schools.

Students of both the schools were provided the cyclostyled copies of verbal creativity instructional materials enough space was left for students, to work out. The investigator read the first half of the story and motivated the students. The children had to solve the puzzles, riddles etc. Only after they solved all the puzzles, the second half was read to them. Before and after the administration of these materials PTC were administered as pre-test and post-test. Then they were given a creativity rating scale.

Findings

1. Out of 3 levels of creative potentials high, middle and low, null hypothesis was rejected in case of middle and low creative potential groups and not in case of high creative potential group.

Hypotheses

1. There will be no significant difference in the effect of verbal creativity instructional materials on the students of different creative potential.

2. There will be no significant difference in the effect of verbal creativity on the students of different socio-economic status.
3.3.3 Study 5

Ashok Nirphasra 6 conducted different experiments for the development of creativity on different samples. This project lasted for five years at Jnana Prabodhini, Pune. The experiments were done on the students ranging from the standards V to IX and on girls or boys of the total population.

These experiments were directly related to 'creativity through school subjects'. To ensure that creativity or creative thinking is developed in a wide range of experience, attempts were being made to introduce principles of creative thinking in every subject. For the experiment, following activities were included:

A. Lectures by the resource persons on:
   1. Recognizing creative students
   2. Blocks to creative thinking
   3. Guiding creative talents
   4. The creative teacher

B. Exercise of the techniques of stimulating creativity:
   1. Brainstorming
   2. Check list

C. Practicum preceded by sort talks by the resource person and followed by discussion.

This much can surely be concluded from their experience, that given freedom to experiment, it is possible ....

1. For everyone concerned and concerned enough, to create a school climate in which creativity can blossom.

ii. For interested teachers to practise principles of enhancing creativity though their daily teaching, to construct innovative exercises in divergent production in almost any subject, and to make 'the Project Method' a fruitful practice.

iii. For teacher innovators to conduct training programmes in creative thinking for school children.

Rejection of null hypothesis in case of high and middle socio-economic status.

Null hypothesis was rejected in both the cases of rural and urban students with respect to the significant difference from pre to post test scores.

Hypothesis

3. There will be no significant difference in the effect of verbal creativity on the students of rural and urban background.
4. There will be no significant difference on male and female students.

Rejection of null hypothesis i.e. both have done better significantly in post-test.

3.3.4 Study-7

The study has been taken by M.N. Deshmukh for a Ph.D. work. It aims to indicate desirable changes which must be brought about in the day-to-day teaching practices to create conductive climate in the class-room.

It has been undertaken with the following specific objectives in view:

1. To find out the extent to which the theoretically postulated creative teaching practices are being used in the present class-rooms.

2. To find out the potential of the theoretically postulated creative teaching in Indian class room, in terms of gains in creative ability.

3. To study the comparative effect of the original teaching practices viz., Traditional, Role-playing and Brainstorming on the development of creative ability and scholastic achievement.

4. To study the differential gain in creative ability of the pupils having varying levels of intelligence and initial creative ability.

5. To study the influence of sex differences on creative ability of the pupils.

6. To study the relationship between intelligence and creative ability.

7. To suggest measures for incorporating application of the findings of this study in the educational system to make it more meaningful, lively and effective.

Instrumentations

To collect the data on these variables, the following tools were used:

1. Class room Creativity Observation Schedule (CCOS) by Denny-1969.


iii. Socio-economic Status Scale (SESS) by Kuppuswamy.
iv. Torrance Test of Creativity Thinking (TTCT) 1966.
v. Minnesota Creative Activity Check list by Torrance 1962.
vii. School Records of the Scholastic Performance of the students.
vii. Students' Reaction Schedule by investigator.

Sample

For the experiment one school was selected from these 20 schools. It was Vidarbha Buniyadi High School, Om Nagar, Nagpur. This school is open for all type, moderate size school. It was therefore considered as a representative one and was selected for the experiment.

After pre-testing, the experiment started in the second week of January and continued for six weeks. 33 lessons including 3 practice lessons, were taken; 5 lessons a week for each of the experimental groups.

The data on the classroom creativity were collected by tool (i) and analysed in terms of relative frequencies of occurrence or non-occurrence of the behaviours and percentages. To compare the 3 treatments in terms of their effectiveness in developing creativity and improving scholastic achievement of the students. The three groups had to be matched statistically for the comparisons. Therefore Multi Factor Analysis of
Covariance (ANCOVA) having control and experimental groups was employed to test the hypotheses related to comparison between groups on post-test scores for various creativity and scholastic achievement variables. The students were again divided into three groups according to different levels of intelligence and initial creative ability. To find out whether these groups differ significantly, on the variable of gains in creative ability, Analysis of variance technique (ANOVA) was employed.

Conclusions

When the two approaches, i.e. role playing and brain storming were compared, brain storming is found more effective than role playing in establishing better teacher pupil rapport, in explicit encouragement to unusual responses and creative thinking, and more interesting to students.

The ANCOVA result indicated significantly higher to scholastic achievement in Marathi language for the students taught through brain storming and role playing than the traditionally taught students, when the initial differences in achievements were adjusted.

The results of the present study indicated significant sex differences in creativity amongst VIII graders. In general, girls were found more creative than boys.
It is, therefore, concluded that creativity and intelligence are moderately positively related at the lower level of I.Q. and that there are sex differences in this relationship, i.e. girls high on intelligence tend to be more creative than boys. It also can be inferred that the children high on verbal ability will tend to be more creative than those who possesses less of it.

3.3.5 Study-3

'A preparation and tryout of divergent thinking programme in maths for Std. VIII' by R.V. Patel.

This study was carried out in rural area of Bayad District. The sample of 60 students was selected from one school. It was divided into 2 groups called experimental and control groups.

Pre-test, post-test design was selected. Verbal creativity test of Baquer Mehdi was used for the same, programme was prepared in Mathematics for the creativity training of the students. Especially 'algebraic expression' was selected topic for it. Ten programmes were prepared in a logical sequence and try out. Those programmes of divergent thinking were implemented by the investigator thrice a week. While the same topic

of algebraic expressions was taught to the students of control group by the traditional method. The pre-test and post-test were conducted and the answer-sheets were scored according to Mehdi. To test the hypothesis, analysis of covariance (ANACOVA) was used to analyze pupils performance on each of the creativity measures i.e. fluency, flexibility and originality, and total creative scores.

Results

The main effect of treatment was significant for total creativity scores, moreover the treatment effect was also significant for fluency and flexibility but not for originality.

3.3.6 Study-9

This study has been carried out by Mulkh Raj Tauli in Punjab. The survey method was considered useful as it enabled to gather data from a relatively large number of cases, at a time. The sample was selected by employing technique of multi-stage randomization of cluster at a district, block, school and levels from Class D high/ higher secondary schools of the Punjab State. The four

---

clusters of districts in the State of Punjab are:

1. Bhatinda, Hoshiarpur, Ropar and Faridkot - More under developed.
2. Sangrur and Perospur - under developed.
3. Patiala, Gurdaspur, Amritsar and Kapurthala - Average level of development.
4. Ludhiana and Jullundur - above average level of development.

Each district has three clusters of blocks i.e. developed, average developed and under developed blocks. One district was selected from each of the 1st and 4th type district randomly. The under developed block was selected from the more under developed district whereas the developed block was selected from the above average developed district to investigate discernible regional differences.

One school at the block head quarter for boys and one
developed and validated. The validity of the CAMT as a measure of creative ability in mathematics was determined by using the factor analysis.

**Findings**

It was found that means of mathematical creativity - fluency, flexibility, originality and composite score of fluency, flexibility and originality ($F + x + O$) for boys are significantly greater than that of girls. It is significant at 0.01 level of significance. The conclusion arrived at is that boys are significantly more creative than girls in mathematics.

It is interesting to note down that there is no significant difference in means of AADD/DB and MUDD/UDB (AAD - Above Average Developed District; DB - Developed Blocks; MUDD - More Under Developed District; UDB - Under Developed Block) with respect to composite score of creative abilities in mathematics.

**3.3.7 Study - 10**

V.K. Shreelatha & Mathew George have undertaken the study as below.

An ordinary private school was the venue of the experiment as there only 12 students in class IX, continuous and intensive interaction was possible between the teacher and the taught. So the sample was selected. Keeping the possibility of personal relationship and in depth interaction in a small class room which is natural. After establishing rapport, the Mehdi's (1972) verbal and non-verbal test of creative thinking were administered as pre-test. Then 17 lessons in Biology were taken involving the pupils according to the lesson plans without disturbing the class time table. After a month post-test was conducted using the same tool. Pre-test and post-test were conducted and the answer-sheets were scored instructions in Mehdi. To test the hypothesis, significance of the difference between the pre-test and post-test raw score means were used.

**Results**

The pre-test and post-test raw scores of 12 pupils for verbal fluency, verbal flexibility, verbal originality, verbal elaboration, non-verbal elaboration and non-verbal originality were found to be high and 't' values were significant at 0.01 level. Hence null hypothesis relating to verbal creative thinking of pupils (4) and non-verbal creative thinking (2) were rejected.
There are two opposite ways of improving the process of creative thinking. (i) To try to improve it directly by establishing creative teacher-pupil relationship and intimate personal contact leading to the qualitative improvement of the teaching-learning process. The discovery method, creative inquire pattern, thought provoking and diversion question, higher order questioning and problem solving approach are usually used in a classroom by a creative teacher. (ii) To recognise the barriers to creative thinking in a classroom and then remove them so that creative classroom climate will facilitate the release of the creative potential. The indirect teaching behaviour (accepting in the fillings of pupils, encouraging their ideas expression, using developing the ideas elicited from pupil) enhances creative thinking process and direct teaching behaviour (directing, criticizing and justifying authority and punishing) discourages it. According to Sandhy (1979) creativity remain undeveloped and un-nurtured in the circumstances of our educational system and society. The success of this experiment was mainly due to the teacher who acted as a pygmalion in the classroom using the two opposite ways of improving the creative thinking of pupils mentioned above. The harmonious blending of suitable classroom activities for the balanced growth development of the cognitive affective and psychomotor domain (confluent education
of the pupils further facilitated and stimulates creative learning with the result that both teacher and the pupils expand potentialities for creative teacher perceives his classroom as a gold mine and his teaching as mining process. An ordinary Indian classroom will become a gold mine when the teacher accepts himself the challenge to become a transformer instead of remaining as an informer.

3.4 Rationale of the Present Study

From the review work in the foregoing section, the several points for developing the creativity in a classroom are worth to be noted.

1. The main purpose of education is the development of mental abilities and thinking power of students. Guilford's concepts of convergent thinking ability, mainly related to intelligence and of divergent thinking ability, mainly related to creativity, have some theoretical weight and practical utility. So such programmes would have to be learned to divergent achievement along with convergent achievement.

2. Creative expression is a form of learned behaviour which can be developed by application of appropriate teaching practices and by manipulating environment conditions in the classroom. It is found that the
gain in creativity can be achieved within a comparatively shorter time of creative instruction in any school subject area or in any school endeavour.

3. A variety of interrelated factors that enhance or hinder creative ability imply that an attempt to develop creative ability will be more effective if the teaching method includes the strategies which are designed to create favourable conditions. The consistent and systematic attempts put by the teachers to provide these conclusive conditions during teaching, can improve the quality of thinking of the students.

When it is seen that as compared to convergent thinking, very little is being done for the development of divergent thinking ability in school. This investigation would prove its worth in enhancing the creativity levels of students in the class-room set up.
CHAPTER IV
DTPM: PLANNING AND DEVELOPMENT

Creative children are assets to the society. Development and progress in various fields of national life depend on creative children. Creativity is not restricted to the chosen few. All children are creative and its dimensions vary from child to child.

- Ali Imam

CONTENTS

4.1 Planning for DTPM
4.2 Construction of DTPM
  4.2.1 Preparation of Multi-response programme
  4.2.2 Construction of Hidden Shapes programme
  4.2.3 Formation of Make-up Problems programme
4.3 DTPM on Anvil
  4.3.1 Pre-pilot tryout
  4.3.2 Pilot tryout
  4.3.3 Final Form DTPM
Planning is a necessary aspect even in our routine work like class-teaching or a picnic. In absence of careful planning there is every likelihood that even a sound research work may reveal misleading results or wrong conclusions. Hence good planning is inevitable for a sound study.

Here the planning of the whole study was divided into two parts regarding the following aspects:

i. Development of Divergent Thinking Programme in Mathematics.

ii. Studies on Creativity.

This chapter deals with the first part i.e. planning and development of the programme.

4.1 Planning for DTFM

Prior to the preparation of the programme, some existing works regarding divergent thinking programme were referred to as reviewed in the previous chapter, with an intention to prepare the base for the types of programmes to be included in the present study. Various types of
educational programmes covering different problems are available on divergent thinking. Some of them are listed here:

i. Multi-response programme
ii. Hidden shapes programme
iii. Make-up problems programme
iv. Ask and guess programme
v. Observe and guess programme
vi. Problem solving programme

Out of these, the first three types of programmes were to be selected for the present study due to the following reasons:

i. The study was specially meant for mathematics as one of the school subjects.

ii. The types of programmes selected should be used in a group, which was not possible for the rest of the programmes.

iii. Items prepared for the present study should be selected in such a way that responses must be verbal.

iv. The whole divergent thinking programme must include all the branches of school mathematics i.e. Arithmetic, Algebra and Geometry.
The forms of items prepared on the basis of selected programme types (as mentioned above) were discussed with the experts working in the academic field and teaching at different stages ranging from primary to higher secondary.

J.P. Guilford\(^1\) has suggested to provide minimum one month's training to get significant change in creativity of the teenagers. According to E.P. Torrance\(^2\) at least two months' training is necessary for a definite change in the creative level of any person. Such different views of the scientists were taken into consideration for the development of the training programme under reference. The above said references indicated that training period should range between one and two months. This got further strengthened through the discussion with the experts and concluded, though arbitrarily, to consider the programme period of six weeks. The total number of items to be formed for the divergent thinking programme was twelve, because the training programme was to be administered for six weeks at a rate of twice a week. These twelve items were distributed as six of multi response type, three of Hidden shapes type and

---


three of Make-up problems type to form the Divergent Thinking Programme in Mathematics.

Nunnally\(^3\) suggested to construct three times more items for the preliminary tryout in the field of mental ability test. Mehrotra\(^4\) recommended double the items of the requirement for the tryout for mental ability tests. In view of the recommendations of Nunnally and Mehrotra, it was thought to prepare 2 to \(2\frac{1}{2}\) times more items for the pilot tryout.

The present study was not an ability test but a training programme, because the tool is going to be used for training and not for testing. For a training programme at least 1\(\frac{1}{2}\) times more items are required for efficient results and for having scope for marginal elimination, if necessary. Considering all the points, it was supposed to construct almost double items for pilot tryout. The number of items to be included in the final, pilot as well as in the pre-pilot forms are given in the following table.

\begin{center}
\begin{tabular}{|l|}
\hline
\end{tabular}
\end{center}

---


<table>
<thead>
<tr>
<th>No.</th>
<th>Programme</th>
<th>Content</th>
<th>Items to be included</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Final Pilot Pre-pilot</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>form form form form</td>
</tr>
<tr>
<td>1</td>
<td>Multi-response type</td>
<td>Algebra</td>
<td>2 3 5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Geometry</td>
<td>2 2 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arithmetic</td>
<td>2 6 8</td>
</tr>
<tr>
<td></td>
<td>Total for 1st Programme</td>
<td></td>
<td>6 11 15</td>
</tr>
<tr>
<td>2</td>
<td>Hidden Shapes</td>
<td>Geometry</td>
<td>3 6 7</td>
</tr>
<tr>
<td>3</td>
<td>Make-up problem type</td>
<td>Algebra</td>
<td>3 6 7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Arithmetic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total items</td>
<td></td>
<td>12 23 29</td>
</tr>
</tbody>
</table>

Keeping in view the requirements of the items in final form, it was decided to construct two and half times more items in the beginning.

4.2 **Construction of DTP**

The divergent thinking programmes consisted of three types of problems. It will be useful to discuss the construction in the following parts:

1. Preparation of Multi-response programme.
3. Formation of Make-up problems programmes.
4.2.1 Preparation of Multi-response programme

As mentioned above, 15 items of this type were prepared in the initial stage. All the branches of school mathematics were included in this type of programme. The study was meant to include the students of the VII grade also. As very little knowledge of Algebra was imparted to the students at this level, the items of Algebra were less in number. For Geometry, a special programme named Hidden shapes programme was to be prepared. Hence only two items of Geometry were prepared for this type of programme.

"Arithmetic is considered to be a queen of Mathematics" is a well-known fact. This was the main reason to prepare more items of Arithmetic for this programme. Moreover there was no scope of using pure Arithmetic in other two types of programmes.

Generally one valid question has only one correct answer. It is not so in the case of divergent thinking. The title "Multi-response type" suggests that the items of this type may have more than one correct responses. The title would be understood clearly from the following illustrations given with some expected responses.

Ex.- 1 Give as many equations as possible having the value 4 for the variable x."
A few of the expected responses for the above item are listed here into 2 parts like common response part and uncommon response part i.e. non-creative and creative parts as under:

Part - I Non-creative responses

\[2x+6, \ x+5=9, \ x-2=2, \ x+0=4, \ x=4\]

Part - II Creative responses

\[\frac{x}{2}=4/3, \ 4/16=1/4, \ \sqrt{2}=2, \ x^2=64, \ 2x+5=16-3\]

Ex. 2 "Give pairs of numbers having the difference of 3 between the numbers of each pair".

Part - I (1,4), (0,3), (-1, -4)

Part - II (1^2, 2^2), (2 3/5, 5 3/5), (\sqrt{4}, \sqrt{25}), (4^0, 4^1)

4.2.2 Construction of Hidden shapes programme

As the aim of the programme is to encourage divergent thinking it is desirable to think of Geometrical shapes from different points of view. As a school subject Geometry is considered to be very tedious and hard for common students. Normally students do not find interest in this subject, they cram some important theorems to get marks. To minimise their phobia for Geometry, this type of items is thought to be prepared. The title "Hidden shapes" and the instructions are likely, to provide inspiration to the secondary school students.
Geometrical figures were given as items for the Hidden shapes programme. The items were thought to be constructed in such a way that the shapes like triangle, rectangle, polygon and circle should be included in one or the other item of this type. From the item of these complex figures, students were supposed to find out the shapes or figures other than Geometrical ones by observing the item from different angles. Initially 7 items of this type were prepared. Some expected responses with original sketches of items are shown as follows:

Ex. (i)

Expected responses -

- Banner
- Hills

- One type of drum
- Umbrella
- Envelope
4.2.3 Formation of Make-up problems programme

According to the planning, the investigator prepared 7 items of this type. This programme was quite different from the previous two types of programmes. The students were trained to make out the questions from the given information after careful reading. Their written presentation should be converted into Arithmetical form simultaneously and finally they are supposed to convert those problems into Algebraic ones i.e. in the form of expression or equation using unknown values like $a$, $b$, $x$, etc. Thus
two branches of school mathematics i.e. Arithmetic and Algebra are covered in this type of programme. According to the investigator this technique may prove interesting, as the process of learning is just the reverse of the routine one. An illustration with some expected responses is given here to understand this type clearly.

Ex.1 "Shardul invests 1/5th of his monthly income of Rs. 2,000/- as savings. He keeps 1/5th of the remaining amount of his income for donation purposes. He pays 1/4th of his income for milk and ghee. His tenant pays him Rs. 325/- as house rent on the 10th day of every month. The company gives him Rs. 400/- as vehicle allowance and medical bills. From this money, he can pay his electric bills as well as municipal tax and educational cess. Moreover he spends 10% of the medical bill for the medicines of his old parents. The rest of the amount of the medical bills is spent as an expense for petrol. The remaining income is spent in miscellaneous household expenditure such as vegetables, fruits, fuel etc."

Construct as many questions related to the accounts as possible with the help of the above data.

Expected responses: The responses would be in three categories as shown below:
poses containing 15 items of Multi-response type, 7 items of Hidden shapes type and 7 items of Make-up problems type programme.

4.3 **DTP on Anvil**

A pool of problems was constructed as discussed above in 4.2. Those problems were to be scrutinised scientifically. The tryout of DTP is very essential for the purpose. The investigator comes to know only after the tryout, how the respondent understands the problem, how he interprets the given data and how he arrives at the conclusions. In order to fulfil these requirements the process of tryout is done at two stages in the present
4.3.1 Pre-pilot tryout

The manuscript containing 29 items in all was given to a very small group of 5-6 pupils for pre-pilot tryout. The main objective of this tryout was to confirm the applicability of the manuscript. Hence no statistical calculations were involved at that level. The specific objectives of this tryout could be listed as under:

1. To see whether the pupils follow the instructions.
2. To confirm whether the pupils follow the language of the problems.
3. To check whether items work well with the students.
4. To find out, if there is any ambiguity in the items.
5. To determine the time limit for each of the items.
6. To fix-up the necessary time intervals for relaxation.

It would be more appropriate to discuss the findings along with the observations of this tryout in three categories as under:
Category I - Multi-response programme

Observations

1. The students could not give many responses of varied nature by applying the same item at a time continuously for 5 minutes.

2. Continuous application of one type of items i.e. only Arithmetical, Geometrical or Algebraical items were found to be monotonous and less interesting.

3. The language of instructions and problems was easy to follow.

4. A small note book with 20 pages could serve the purpose as an answer booklet.

5. The students could write down the items correctly, which were announced by the experimenter.

6. A few items were found to be difficult, being of higher level.

Important conclusions regarding this tryout were drawn from the above observations as listed here.

1. It was finalised that the item should be given at 3 stages with two intervals during one school period. The pattern for each item was as under:
(a) 2 minutes for the 1st stage responses.
(b) Interval for one minute.
(c) 3 minutes for the 2nd stage responses.
(d) Relaxation for one minute.
(e) 4 minutes for the 3rd stage responses.

2. Items of this type of programme should be given alternately (i.e. Arithmetical, Algebraical and Geometrical alternately) to avoid monotony as shown in table 4.2.

Table 4.2

<table>
<thead>
<tr>
<th>No.</th>
<th>Content</th>
<th>Item Nos.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Arithmetic</td>
<td>1, 3, 5, 7, 9, 11</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>Algebra</td>
<td>2, 6, 10</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Geometry</td>
<td>4, 8</td>
<td>2</td>
</tr>
</tbody>
</table>

In the testing programme also the similar pattern was thought to be kept. (It is shown in table 4.3)

3. No printed copies of programme booklet were necessary for this type of items, because they could be written easily on the black-board.

6. Difficult items were dropped out and the number of items was finalised to 11 for pilot tryout.
Observations

1. The students could not give many responses of varied type by applying the same item at a time continuously for 5 minutes.

2. The items proved to be very interesting.

3. They were not able to draw the exact sketches in their answer-booklets only by observation of the item.

4. Individual copy of the item was necessary.

5. Out of 7 items one was found to be very simple and repetitive.

Conclusions

1. Items should be given as decided in category I conclusion I.

2. Students should be supplied a tracing paper along-with the answer booklet to get exact sketches from the given item.

3. Xerox copies of the items should be prepared and supplied individually.

4. Total 6 items were selected from 7 items of the manuscript.
**Category III: Make-up problems programme**

**Observations**

1. This type of items was less interesting and difficult.
2. The language of instructions was found to be hard to follow.
3. The students were not able to give complete responses, especially no Algebraic forms were obtained.
4. Time limit of 5 minutes (continuous 5 minutes) was found to be insufficient.

**Conclusions**

1. It was decided to supply xerox copies of each item to the pupils.
2. It was found necessary to give the items at 3 stages as in the previous types, but the time duration and intervals were to be changed as under:
   
   (a) 5 minutes for the 1st stage responses.
   (b) relaxation for 1 ½ minutes.
   (c) 4 minutes for the 2nd stage responses.
   (d) interval for 1 ¼ minutes.
   (e) 3 minutes for the 3rd stage responses.
3. Each item should be read at least twice (and with explanations, if necessary) loudly by the experimenter so as to enable the students to follow.

4.3.2 Pilot tryout

The divergent thinking programme had been ready for pilot tryout. It contained 11 items of Multi-purpose type, 6 items of Hidden-shapes type and 6 items of Make-up problems type i.e. total 23 items as shown in Appendix-I.

As the pilot tryout was the final stage of tryout, it required caution in administration. Main objective of this tryout was to analyse and select the items for final testing. Besides this main objective some specific objectives should be kept in mind during the tryout as under:

1. Instructions for each of the programmes were to be finalised.

2. To check the reactions of pupils to the divergent thinking programme, which was prepared after modifications and due corrections.

3. The utility of the revised answer booklet (i.e. notebook along with tracing paper) was to be checked up and finalised.
4. To get the general idea about the time requirement, which was finalised during pre-pilot tryout.

5. To select the items for the final testing according to the response analysis.

During the course of application of the programme, the following factors had to be reckoned with (i) Time limit, (ii) Instructions for the programme, (iii) Selection of the sample and (iv) Mental readiness of the pupils.

(1) **Time Limit**

This factor should be discussed in two ways i.e. time limit per item and time limit for the whole programme. This programme contains 23 items in all. Each item requires 10 to 15 minutes to be completed in 5 steps as concluded in the pre-pilot tryout. So 40 minutes time would be required to complete two items of different types. Generally at the secondary level, schools have a period of 40 minutes time. As the whole programme was to be completed within 6 weeks, it was decided to take 2 periods per week say one period on Monday and the other on Thursday.

(ii) **Instructions for the Programme**

Instructions used for pilot testing should be similar to those for final testing. From the observations
of the pre-pilot tryout, some instructions with modifications were prepared. As the divergent thinking programme contained 5 of components types, the instructions were prepared according to the programme types.

(iii) Selection of the Sample

In the field of psychological testing, the sample size should be of 300 students at the minimum for standardisation. The present study was, however, to prepare the programme and not to standardise it. The sample of 115 students of one school, therefore, can serve the purpose. The sample selected for pilot tryout should be similar to one that would be used for final testing from the points of view of area, educational level, socio-economic level and such other factors. Considering all these factors, R.C. Patel High School of Ahmedabad city was selected for pilot tryout. The sample consisted of 115 students, out of whom 52 students of the std. VIIIth and 63 students of the VIIth grade were selected.

(iv) Mental readiness of the students

As the success of any test or programme depends upon the respondents, it was very essential to think of their mental condition. It was necessary to give the items of two different types within one school period for the
constant mental freshness and better responses from the students. This programme contained almost double items (11) of Multi-response type of those of other two types (i.e. 6 of Hidden shapes type and 6 of Make-up problems type.) As Hidden shapes type was more interesting and Make-up problems type was less interesting, the items of these two types should be selected alternately along with 1 item of Multi-response type throughout the programme. The pattern finalised for the programme (from educational and psychological point of view) is shown in the table 4.3.

<table>
<thead>
<tr>
<th>Table 4.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROGRAMME PATTERN OF PILOT WORK</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week No.</th>
<th>Period No.</th>
<th>Programme No.</th>
<th>Item No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Monday I, II</td>
<td>1(I), 1(II)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Thursday I, III</td>
<td>2(I), 2(III)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Monday I, II</td>
<td>3(I), 2(II)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Thursday I, III</td>
<td>4(I), 2(III)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Monday I, II</td>
<td>5(I), 3(II)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Thursday I, III</td>
<td>6(I), 3(III)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Monday I, II</td>
<td>7(I), 4(II)</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Thursday I, III</td>
<td>8(I), 4(III)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Monday I, II</td>
<td>9(I), 5(II)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Thursday I, III</td>
<td>10(I), 5(III)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Monday I, II</td>
<td>11(I), 6(II)</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Thursday III</td>
<td>6(III)</td>
<td></td>
</tr>
</tbody>
</table>
It was decided to supply xerox copies of Hidden shapes type and Make-up problems type for pilot tryout as well as for final testing. Practical hinderness like electric power out and local strike came in the way. Copies of Hidden shapes type only were available. So at the last moment the investigator was compelled to change the decision for Make-up problems items. The item was written on the roll-up board, whenever necessary. It was, therefore, an additional special objective to make the use of roll-up board for final testing. The responses of the students are discussed here to the types of the programme. Only creative responses are listed and shown in the Appendix I(a) (b).

Table 4.4. Make-up problems programme. Number of responses was an important criterion for the items to be included in final programme of this type (i.e. Make-up problems programme). Table 4.4 gives the number of creative responses along with remarks and new order per item. Appendix-I C gives the actual creative responses of the students of the Stds. VII & VIII.
Table 4.4

FREQUENCY OF CREATIVE RESPONSES OF MAKE-UP PROBLEMS PROGRAMME

<table>
<thead>
<tr>
<th>Item No.</th>
<th>Creative Responses</th>
<th>Remarks</th>
<th>New order</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0- 5%</td>
<td>12-11%</td>
<td>20- 19%</td>
</tr>
<tr>
<td>1</td>
<td>2 2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>4 3 2 1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>1 9 3 2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>5 5 - 2</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>11 4 1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>8 1 1 2</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Rare responses are obtained so it is a hard item dropped out.

Less responses are obtained so it is not selected.

More and varied responses are available hence the item was selected.

Many responses are obtained but variation is less so it is selected as a practice item.

Many responses and highly creative too. selected for programme.

Many responses with more variation, so selected for final form.

N.B. (i) Item Nos. 4 and 6 have equal number of responses. So the selection was made according to the responses in more categories and the values of life woven in the item No. 6.
(11) No single responses of the last category i.e. 28.32% is available, hence only 4 categories are shown in the next table (Table IV.B) in Appendix I.

4.3.3 Final Form - DTPM

It was now very easy to select the items for the final form of DTPM, from the response analysis. The reasons for selection or rejection of the items are given in the tables IV, V and VI(A). Here is the table 4.5 to know about the selected items per each type of programme.

<table>
<thead>
<tr>
<th>No.</th>
<th>Programme</th>
<th>Content</th>
<th>Item No.</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pilot</td>
<td>Final</td>
</tr>
<tr>
<td>I</td>
<td>Multi-response programme</td>
<td>Arithmetic</td>
<td>5 0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Algebra</td>
<td>2 3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Geometry</td>
<td>4 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8 5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 0</td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Hidden shapes programme</td>
<td>Geometry</td>
<td>4 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 3</td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Make-up problems programme</td>
<td>Arithmetic</td>
<td>3 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&amp; Algebra</td>
<td>4 0</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 3</td>
<td></td>
</tr>
</tbody>
</table>

N.B.: No. zero (0) is denoted for practice item
This final form of TPM as shown in the Appendix-II should be used for six weeks. It was decided to execute the programme once a week throughout the training. Thus six weeks were necessary for the training programme. Each period is allotted to the type of programme with specific items as shown below:

Table 4.6

<table>
<thead>
<tr>
<th>Period No.</th>
<th>Programme item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I(1) II(1) -</td>
</tr>
<tr>
<td>2</td>
<td>I(2) - III(1)</td>
</tr>
<tr>
<td>3</td>
<td>I(3) II(2) -</td>
</tr>
<tr>
<td>4</td>
<td>I(4) - III(2)</td>
</tr>
<tr>
<td>5</td>
<td>I(5) II(3) -</td>
</tr>
<tr>
<td>6</td>
<td>I(6) - III(3)</td>
</tr>
</tbody>
</table>

Here the first part of the planning has been over, but a careful part is remaining which is discussed in the next chapter.
CHAPTER V

STUDY DESIGN: ITS EXECUTION

The basic reason for planning and organizing is to facilitate the research. Any research project is made of specifics. Specific hypotheses referring to the variables, conditions, factors or subjects or project are required. These specifics will vary with the nature and complexity of the research study, but it is attention to the details of the specifics that brings a research project to a successful conclusion.

- William Viersma

CONTENTS

5.1 Study Plan
   5.1.1 Selected Psychological Tools
   5.1.2 Sample Selection
   5.1.3 Hypotheses

5.2 Statistical Designs
   5.2.1 Types of Design
   5.2.2 ANCOVA - Why?
   5.2.3 ANCOVA - What?

5.3 Implementation
   5.3.1 Familiarisation
   5.3.2 Response Analysis
   5.3.3 Observations
Research design is a strategy on paper like an architect's plan. Certain fundamental steps of research design must be given due importance when proposed to be used. The operations of the design i.e. planning must be carried out with patience and accuracy. As mentioned in the last chapter, planning has been devised in two parts for better presentation of this work. The remaining second part of it has been discussed here with reference to study plan, research design and its implementation.

5.1 Study Plan

The plan was designed with the help of selected tools, sample and the hypotheses which are narrated to present their importance and due weightage.

5.1.1 Selected Psychological Tools

The tools, selected to study the creative levels of the school students are explained under this caption — viz., PTC, PDM and Opinionnaire.
5.1.1.1 Passi Test of Creativity (PTC)

The PTC is a test battery of 6 tests. These tests are classified as follows:

(a) Tests consisting of verbal tasks viz., the seeing problems test, the Unusual Uses Test and the Consequences Test.

(b) Test with verbal responses task using mostly non-verbal stimuli viz., Test of Inquisitiveness.

(c) Test consisting of non-verbal tasks comprising of Square Puzzle Test and the Block Test of Creativity.

Of the three types, discussed above, two types i.e. (a) and (b) were selected for the study as the last (c) type is not applicable as a group test. After the selection, they were translated and printed in Gujarati. A copy of it is shown in the appendix-VI.

Now the students selected for the work undertaken, were coming from VII and VIII grades. The PTC on the other hand has been standardised for IX, X and XI grades. It was necessary, therefore, to apply the translated PTC to a small group of the VII and VIII grades to check the applicability of the tool within the time limit prescribed
For it. As the students were of younger age group, time limit had to be changed, which is shown in the following table for comparison and clarity.

Table 5.1
TIME LIMIT FOR PTC

<table>
<thead>
<tr>
<th>No.</th>
<th>Type of Test</th>
<th>Name</th>
<th>Original in minutes</th>
<th>Revised in minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(a)</td>
<td>Seeing Problems Test</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>(a)</td>
<td>Unusual Uses Test</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>(a)</td>
<td>Consequences Test</td>
<td>8</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>(b)</td>
<td>Test of Inquisitiveness</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total (a+b)</td>
<td>30</td>
<td>40</td>
</tr>
</tbody>
</table>

For the pilot test, 8 to 10 students were selected from the same grades i.e. VII and VIII grades. The same group of the students was given the translated PTC after a fortnight as a post-test. Test-retest reliability reliability was computed from their responses and found to be 0.72. It was advisable now to use newly prepared PTC as a standard tool.

The administration of PTC was carefully done with the help of the teachers of the school, selected as a
sample. For the purpose, sitting arrangement of the students was made in such a way that rare chances were therefore copying. At the same time it was observed that the time limit should be followed strictly. From psychological points of view these precautions were most essential.

5.1.1.2 DTPM

Divergent Thinking Programme in Mathematics prepared by the investigator is an instrument to enhance the creativity of the students. It consists of three parts viz., Multi-response programme, Hidden shapes programme and make-up problems programme as shown in Appendix-II. Its detailed description is given in the previous chapter.

5.1.1.3 Opinionnaire

It is a tool developed and used for the follow-up of the training programme. It was prepared in a regional language Gujarati, for better understanding of the students. The tool gave the analysis regarding the attitude of the students towards ITPM. It consisted of 6 questions, from which first 4 questions were similar to a five point rating scale. Each of the four questions contained five opinions showing positive attitudes in ascending orders.
towards DTPM. Other two questions no. 5 and 6 were binary type and the last 2 were open response type. See Appendix VII.

Different tools as discussed here, were to be used for the students selected as a sample. The discussion now for the sample selection has been done for the purpose.

5.1.2 Selection of the Sample

It is very difficult to work on the total population for any research, as the factors like time, energy and money are limited. Owing to these limitations, it was decided to work on a sample for the present study. Sampling is a process or a tool which helps to know the characteristics of the population by examining only a small portion drawn from it. So measures computed from the sample were used to make inferences about the population.

The characteristics of the sample should be identical to those of the population. The real worth lies in the accuracy and representativeness of the sample and of size. Representative sample should be carefully determined for the purpose. According to Johnson.¹

"A representative sample is defined as one, with which the measurement made on its units are equivalent to those which would be obtained by measuring all the elements of the population, except for the inaccuracy due to the limited size of sample."

Such samples may be of various types among which the following classification is specific and useful too:

i. Random Sampling.
ii. Stratified Sampling.
iii. Quota Sampling.
iv. Multi-stage Sampling.
v. Systematic sampling.
vi. Double Sampling.
vii. Area Sampling.
viii. Purposive Sampling.

Here it would be necessary to note that Garrett has suggested 4 main types of sampling, which cover all the above varieties. According to him the methods are as under.²

i. Random Sampling.

ii. Stratified/quota Sampling

iii. Incidental Sampling

iv. Purposive Sampling

Of these types, the investigator had to select such a sample, which would satisfy the following characteristics:

(a) In general, IQ of the students should be higher than the normal one.

(b) Socio-economically the students should be from affluent group.

(c) The school should be known to the experimenter for easy approach and full co-operation of the staff and students as well.

(d) The school should be one complex having pre-primary to higher secondary education so as to maintain the uniform psychological atmosphere.

(e) The school should have co-educational system at all the grades for sex-wise comparison of creativity.

(f) Each grade should have at least three classes to compare three treatment groups. Moreover selection of the grades should also be rationale.
Looking to the above requirements, the investigator selected the purposive sampling technique for the study.

**Purposive Sampling**

This technique is used in different senses to mean the subjective methods of sampling. In the most general sense, it means selection according to some purposive principles. Claims have sometimes been made that this method gives "More representative samples than objective methods". H.E. Garrett\(^3\) says - "A purposive sample may be expressly chosen, because in the light of available evidence, it mirrors some larger group with reference to a given characteristic".

It is also beneficial to note that random sampling for ula apply more or less accurately to purposive samples.

A school complex satisfying all the requisite conditions named Shardamandir Vidya Mandir was selected for the purpose. It is situated in Ellisbridge area of Ahmedabad city. Total 271 students i.e. 130 students of the grade VII and 141 students of the grade VIII had participated. The selection was made of VII and VIII grades, because

\(^3\) Ibid., p. 207.
(a) A child passes through the transitional age of 12 to 13 years at this stage.

(h) The educational subject especially Mathematics becomes wide at the secondary level consisting of three separate branches viz., Algebra, Geometry and Arithmetic instead of Arithmetic only. So the effect of the subject may be there on creativity.

(o) The approach to the subject-Geometry is changed from concrete to abstract at the secondary level, which may have some effect on creativity.

(d) As the grade VII is the final year of primary education and grade VIII is the starting year of secondary education, significant difference in creativity may be obtained.

After the selection of the grades three treatment groups were to be formed having identical characteristics from the point of view of IQ level, socio-economic status and co-education. The investigator consulted the principal and the concerned teachers of the school for the purpose. According to them the classes were similar from all the above psychological points of view at both the grade levels. Hence the classes themselves were considered as groups. Out of these 6 classes or divisions 3 pairs or groups,
viz., A, B and C were made, each containing one class of either grade. Division A was a pair to which was assigned the programme with feedback. Pair of division B was assigned the programme without feedback and the last pair of division C was considered as control group i.e. no training programme was supplied.

**Sample for ANCOVA**

From the sample selected it is obvious that there were three independent variables viz., (a) Treatment, (b) Grade and (c) Sex in this study. The first factor varied in 3 respects according to the programme given. The second factor of variable had 2 types of grade VII and VIII; and the last factor possesses 2 sexes i.e. boys and girls. Thus the total number of cells rendered would be $3 \times 2 \times 2$ i.e. 12. Statistically minimum 6 subjects per cell are required for data analysis. So at least 72 students are necessary for the ANOVA as well as for ANCOVA. Each class of the sample consisted of minimum 42 students. They all were arranged alphabetically and sex-wise in their muster roll. With the sufficient number of students per class it was possible to get 7 numbers instead of 6 per cell for the experimenter. Every third number in the muster roll was selected for the study. Thus totally 84 students for all the 12 cells were obtained as shown in
the table below:

Table 5.2
MATRIX OF THE SAMPLE FOR ANCOVA

<table>
<thead>
<tr>
<th>Grade</th>
<th>Sex</th>
<th>Treatment</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VIII</td>
<td>Boys</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>VII</td>
<td>Boys</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Girls</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>28</td>
<td>28</td>
</tr>
</tbody>
</table>

This ANCOVA sample was used to check the following hypotheses.

5.1.3 Hypotheses

The following are the hypotheses to be checked during the study.

1. Creativity is increased by the divergent thinking programme in Mathematics with and without feedback.

2. Fluency, flexibility and originality - the creative components are increased by divergent thinking programme in Mathematics with and without feedback.
3. There is no significant sex difference in creativity scores measured on post-tests.

4. There is no significant grade difference in creativity scores measured on post-tests.

5. There is no significant difference in adjusted mean scores of the students possessing high and low creative levels.

6. There is no significant difference between adjusted mean scores of the students showing good and poor opinions towards DTPX.

5.2 Statistical Tools

Statistical tools have to be adopted for the testing of the hypotheses. Main tools-techniques are enlisted and discussed here in brief, out of which the investigator has made use of the techniques, which embrace the needs of the method adopted. Reasons and explanations for making selection of these techniques are vividly set out under this caption.

5.2.1 Statistical Techniques or Experimental Techniques

Different types of experimental designs can be divided into two groups as: 

5.2.1.1 Single Group Designs

Single group experiments do not involve a separate control or comparison group. These designs are further classified in the following manner:

a. One-shot case study.

In this technique a single group or person is exposed to some experimental treatment. The one shot case study is so named, because it is often used in case studies. It might also be appropriately called a single group after only experiment to point out that observations are made after the introduction of the experimental variable.

b. The one-group pre-test, post-test Design

It is one form of repeated measurements design. Since there are two measurements for each S, there may be systematic differences in how Ss respond to treatment-1 and treatment-2 that reflect differences.

c. The Time-series experiment

This is a type of longitudinal research, where Ss undergo repeated measurements both before and after the introduction of the experimental variable.
d. The Equivalent Time-sampling Design

One way to control history in some designs is to randomly vary the presentation of $x$ so that at times it is present and at times it is absent. An alternative possibility is to compare $x_1$ and $x_2$. In this way the experimenter can compare the relative effects of two experimental treatments rather than of one treatment and a control. This method eliminated the effects of history, because $x$ is presented more than once but it introduces a few other problems.

e. The Equivalent Material Design

In single-group repeated measurements designs, the introduction of $x$ may carry over from one occasion to another.

This design is exactly the same as the above (d) design except that different materials are introduced throughout the course of experiment.

5.2.1.2 Separate Control Group Designs

Such experiments require at least one comparison. Comparison may be between two or more experimental treatments or between groups exposed to $x$ and groups not exposed. Some well-known techniques are like these.
(a) Static Group Comparison

When applied to the static group comparison the term "pre experimental" is unusually descriptive, because this type of design leaves many factors uncontrolled. The difficulty with the design is that investigator has no way of knowing, if the groups were equivalent before the introduction of x. Another difficulty with this design is morality but there could be no experimental morality, if groups remained unchanged throughout the entire experiment.

(b) The Pre-test, Post-test control Group Design with Randomisation

This is the first "true experimental" design, because major controls are provided for internal validity and for at least some sources of external validity. The effects of history can be disregarded because anything that affects the $O_1 \ldots O_2$ difference is also likely to affect differences between $O_3$ and $O_4$, assuming of courses that experimental and control groups are tested together and at the same time.

(c) The Solomon Four Group Design

In an effort to eliminate some of the difficulties in generalising with the above (b) design, Solomon proposed using four groups. In this technique the last two groups
receive no pre-test and all the groups are initially equivalent through randomisation. Hence investigator can determine the effect of pre-test $O_1$ and $O_3$. Most of the major variables are controlled here in this design, so Campbell and Stanley consider it to be a true experimental design.

(d) **The Post-test only Control Group Design**

In this technique only the last two groups in the Solomon four group design are employed, providing an experimental and a control group, but no pre-testing. This is the third and last of the true experimental designs.

(e) **The non-equivalents Control Group Design**

This Quasi-experimental design makes use of intact groups of classrooms which are formed on the basis of some natural grouping. Thus, experimental and control groups are not formed by randomly assigning Ss although they could be matched. A minimum requirement for this technique is that pre-test scores for the experimental and control groups should be as similar as possibility.

(f) **Separate-Sample Pre-test, Post-test Design**

At times experimenter may have to work with large but separate samples of groups of Ss who cannot be selected
at the same time. This technique allows the investigator to make a comparison between groups receiving X and those not exposed to X.

To get the comparative idea about all the described techniques, table 5.3 is given on the next page. It gives major advantages and disadvantages of the experimental designs.

Table 5.3

Looking to the above one can infer that separate control group design (i.e. technique from type ii) is the applicable type for the study undertaken. Moreover (b) technique i.e. the pre-test - post-test control group design with randomisation is the most suitable to be adopted for the research. Justification of the adopted technique could be given as:

1. Selection is eliminated here because Ss have been assigned at random to experimental and control groups.

2. Instrumentation can also be controlled by having the same observers participate with both groups.

3. Because there is a control group comprised of the same type of Ss as are in the experimental group,
### Major Advantages and Disadvantages of Different Experimental Designs

<table>
<thead>
<tr>
<th>Designs</th>
<th>History</th>
<th>Maturation</th>
<th>Testing</th>
<th>Instrumentation</th>
<th>Regression</th>
<th>Selection</th>
<th>Mortality</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Single-Group Designs:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. One-shot case study</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Does not allow for comparison of changes; no premeasures.</td>
</tr>
<tr>
<td>2. One-group pretest-posttest design</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>A type of repeated measurement design but with a single group.</td>
</tr>
<tr>
<td>3. Time-series</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Leads to a complex statistical analysis.</td>
</tr>
<tr>
<td>4. Equivalent time samples</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Generalization is only to other groups which are repeatedly tested.</td>
</tr>
<tr>
<td>5. Equivalent materials design</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Generalization again restricted to groups tested repeatedly.</td>
</tr>
<tr>
<td><strong>Separate Control Group Designs:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Static-group</td>
<td></td>
<td>?</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>Along with designs 1 and 2, this is a pre-experimental design.</td>
</tr>
<tr>
<td>7. Pretest-posttest control group design with randomization</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>A true experimental design; generalization restricted to other pre-tested groups.</td>
</tr>
<tr>
<td>8. Solomon four-group design</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Another true experimental design; requires use of multiple groups.</td>
</tr>
<tr>
<td>9. Posttest-only control group design</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>A third true experimental design.</td>
</tr>
</tbody>
</table>
regression can be ruled out.

iv. The experimental and control groups are tested together and at the same time.

v. The effects of experimental mortality can also be checked by examining the pre-test scores of those who failed to show up for the post-test comparison.

5.2.2 ANCOVA - Why?

The selection of the technique was based upon the multiple advantages of ANCOVA as shown in the table 5.3. Certain requirements for this technique should, however, be fulfilled before its use. According to Gilbert Sax⁴, the following assumptions are necessary to be satisfied.

1. The covariate is linearly related to the dependent variable.

2. The correlation between pre-test and post-test scores must be relatively high but not necessarily positive.

3. The initial differences among groups on the covariates should be random.

---------

4. The covariate is obtained prior to the introduction of the experimental treatment.

Here the investigator had computed the correlation coefficient between the scores of pre-test and post-test administered to 271 pupils. It was found to be 0.68. As the coefficient of correlation was high, the basic two assumptions underlying ANCOVA were satisfied. The initial differences among groups on the covariates have been randomised by selecting the subjects scientifically as discussed in 5.1.2. The covariate was the pre-test score on the creativity test. Pre-test was administered before the different treatments were given to the experimental groups.

5.2.3 ANCOVA—What?

The computations for the analysis of covariance i.e. ANCOVA are explained in this caption. Computations for ANCOVA according to B.J. Winer for single factor experiment, test of homogeneity and the ANCOVA (analysis of covariance) for factorial experiment can be represented by the following tables.

Table 5.4

<table>
<thead>
<tr>
<th>i</th>
<th>(2x_i)</th>
<th>(\sum X_i^2)</th>
<th>(2xy_i)</th>
<th>(\sum X_{ij}Y_{ij})</th>
<th>(2y_i)</th>
<th>(\sum Y_i^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(3x_j)</td>
<td>(T_x^2/n)</td>
<td>(3xy_j)</td>
<td>(T_xT_y/n)</td>
<td>(3y_j)</td>
<td>(T_{yj}^2/n)</td>
<td></td>
</tr>
<tr>
<td>ii</td>
<td>(E_{xx} = (2x) - (3x))</td>
<td>(E_{xv} = (2xy) - (3xy))</td>
<td>(E_{vv} = (2y) - (3y))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(E_{xv} = (2xy) - (3xy))</td>
<td>(E_{vv} = (2y) - (3y))</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iii</td>
<td>((1x)' = G_x^2/kn)</td>
<td>((1xy) = G_xG_y/kn)</td>
<td>((1y) = G_y^2/kn)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>((2x) = \sum (2x))</td>
<td>((2xy) = \sum (2xy))</td>
<td>((2y) = \sum (2xy))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>((3x) = \sum (3x))</td>
<td>((3xy) = \sum (3xy))</td>
<td>((3y) = \sum (3xy))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(- (\sum T_x^2)/n)</td>
<td>(- (\sum T_xT_y)/n)</td>
<td>(- (\sum T_{xy}^2)/n)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>iv</td>
<td>(S_{xx} = (2x) - (1x))</td>
<td>(S_{xv} = (2xy) - (1xy))</td>
<td>(S_{vv} = (2y) - (1y))</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(E_{xx} = (2x) - (3x))</td>
<td>(E_{xv} = (2xy) - (3xy))</td>
<td>(E_{vv} = (2y) - (3y))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(T_{xx} = (3x) - (1x))</td>
<td>(T_{xv} = (3xy) - (1xy))</td>
<td>(T_{vv} = (3y) - (1y))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>v</td>
<td>(S_{vv} = S_{vv} - (S_{xy}^2/S_{xx}))</td>
<td>(E_{vv} = E_{vv} - (E_{xy}^2/E_{xx}))</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(T_{vv} = S_{vv} - E_{vv}')</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.4: Computational Formulas for Analysis of Covariance
### Table 5.5

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>SS</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Within-class residual</td>
<td>$E'<em>{yy} \cdot E</em>{yy} - (E^2_{xy}/E_{xx}) = E_{yy} - b_kE_{xy}$</td>
<td>$k(n - 1) - 1$</td>
</tr>
<tr>
<td>Residual w. class variation using individual w. class regression</td>
<td>$S_1 = E_{yy} - \sum b_{k'}E_{xy}$</td>
<td>$k(n - 1) - k$</td>
</tr>
<tr>
<td>Difference between the $b_{k'}$ and $b_k$</td>
<td>$S_2 = [E_{yy} - b_kE_{xy}] - [E_{yy} - \sum b_{k'}E_{xy}]$</td>
<td>$k - 1$</td>
</tr>
<tr>
<td>Reduced treatment</td>
<td>$T_{yyR} = T_{yy} + b_kE_{xy} - b_S S_{xy}$</td>
<td>$k - 1$</td>
</tr>
<tr>
<td>Residual b. class variation using b. class regression</td>
<td>$S_3 = T_{yy} - b_T T_{xy}$</td>
<td>$k - 2$</td>
</tr>
<tr>
<td>Difference between $b_T$ and $b_k$</td>
<td>$S_4 = [S_{yy} - b_S S_{xy}] = [S_{yy} - (b_T T_{xy} + b_E E_{xy})]$</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>$S'<em>{yy} = S</em>{yy} - b_S S_{xy}$</td>
<td>$kn - 2$</td>
</tr>
</tbody>
</table>

**Table 5.5: Partition of Residual Variation about Overall Regression**
### Table 5.6

<table>
<thead>
<tr>
<th>(1)</th>
<th>(1x) = ( G_x^2/npq )</th>
<th>(1xy) = ( G_xG_y /npq )</th>
<th>(1y) = ( G_y^2/npq )</th>
</tr>
</thead>
<tbody>
<tr>
<td>(2x)</td>
<td>( \Sigma X^2 )</td>
<td>( \Sigma XY )</td>
<td>( \Sigma Y^2 )</td>
</tr>
<tr>
<td>(3x)</td>
<td>( (\Sigma A_x^2)/nq )</td>
<td>( (\Sigma A_xA_y)/nq )</td>
<td>( (\Sigma A_y^2)/nq )</td>
</tr>
<tr>
<td>(4x)</td>
<td>( (\Sigma B_x^2)/np )</td>
<td>( (\Sigma B_xB_y)/np )</td>
<td>( (\Sigma B_y^2)/np )</td>
</tr>
<tr>
<td>(5x)</td>
<td>( (\Sigma AB_x^2)/n )</td>
<td>( (\Sigma AB_xAB_y)/n )</td>
<td>( (\Sigma AB_x^2)/n )</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
A_{xx} &= (3x) - (1x) \\
B_{xx} &= (4x) - (1x) \\
(i) \quad AB_{xx} &= (5x) - (3x) \\
&= (4x) + (1x) \\
E_{xx} &= (2x) - (5x)
\end{align*}
\]

\[
\begin{align*}
A_{xy} &= (3xy) - (1xy) \\
B_{xy} &= (4xy) - (1xy) \\
A_{vy} &= (5xy) - (3xy) \\
&= (4xy) + (1xy) \\
E_{vy} &= (2xy) - (5xy)
\end{align*}
\]

\[
\begin{align*}
A_{vv} &= (3y) - (1y) \\
B_{vv} &= (4y) - (1y) \\
AB_{vv} &= (5y) - (3y) \\
&= (4y) + (1y) \\
E_{vv} &= (2y) - (5y)
\end{align*}
\]

\[
\begin{align*}
&\quad F_{vy}' = F_{yy} - (E_{xy}'/F_{xx}) \\
&\quad (A + E)'_{yy} = (A_{yy} + E_{yy}) - \frac{(A_{xy} + E_{xy})^2}{A_{xx} + E_{xx}}, \\
&\quad A_{yy}' = (A + E)'_{yy} - E_{yy} \\
&\quad (B + E)'_{yy} = (B_{yy} + E_{yy}) - \frac{(B_{xy} + E_{xy})^2}{B_{xx} + E_{xx}}, \\
&\quad B_{yy}' = (B + E)'_{yy} - E_{yy} \\
&\quad (AB + E)'_{yy} = (A_{yy} + E_{yy}) - \frac{(AB_{xy} + E_{xy})^2}{A_{E_{xx}} + E_{xx}}, \\
&\quad AB_{yy}' = (AB + E)'_{yy} - E_{yy}
\end{align*}
\]

Table 5.6: Computational Formulas for the Analysis of Covariance in a Factorial Experiment
5.3 Implementation of the Programme

Resultant work derived from the use of the foregoing tools, techniques etc., is elaborately discussed in this caption under three heads:

i. Familiarisation with the programme

ii. Response analysis

iii. Observations during implementation

5.3.1 Familiarisation with the Programme

Instructions, flow chart of the programme and the experimental work done form parts of this head.

6. Ibid. p. 773.

7. Ibid. p. 787.
5.3.1.1 Instructions

It was observed that there was no need to make any change in the general instructions given, during the pilot try-out as they proved to be adequate for type I and II. But the problem in type III i.e. the make-up problems programme required some modifications as discussed earlier in the chapter IV i.e. in 4.3.1 category III observations. This was the main reason to revise the specific instructions of the type III for the final tryout.

Stressing importance of the directions given in the programme manual, Thorndike states:

"It is very important that the instructions be clear and adequately detailed. When the test is of a familiar form and the procedures are simple, a brief paragraph of instructions will suffice."

The instructions need full details, such as method of reading the problem, explanation regarding the type of work and the importance of such work. Thus the directions for administering the DTPM were prepared minutely as shown in Appendix V.

5.3.1.2 Flow chart of the Programme

The following flow chart will give the idea of the study at a glance. The detailed discussion given below will make it clearer.

---

Flow chart (After the page no. 129)

Two items with the necessary discussion and testing required one period of 40 minutes in the tryout process. The whole programme consisted of 12 items. So the time required for the training was six periods. One period per week was necessary, so that training lasted for 6 weeks i.e. 1½ months, as shown in the table 4.6.

Implementation started with PTC as a pre-test. It was given to all the three classes of 7th grade at a time, in a big hall. Three teachers of the school complex assisted the investigator during the testing. On the same line 3 classes of the grade VIII were given the test on the same date.

By the next week of the pre-test, two pairs of each group, (as discussed in 5.1.2) were selected for experimentation. The third pair was termed as a control group i.e. no
programme was to be given to the students of that group (means group of division - C of both the grades). For the experimentation, classes were treated separately. The 7th graders had two periods from 10-40 a.m. to 12-00 p.m. and the 8th graders had starting two periods from 12-15 p.m. to 1-45 p.m. Hence it was very convenient to complete two training items of all the four classes on the same day.

5.3.1.3 Experimental work done

On the first day of training the students were supplied a small note book as an answer booklet. Answer booklet (i.e. note book with trace papers) is shown in Appendix V. On the front page of answer booklet, they were requested to give their required personal data. After they had finished their work, the investigator established the rapport with some introductory remarks like these:

"Today we are going to do some mathematical work in a typical way. You will be supplied a problem. You will have to think about the problem and give the answer. One thing you should bear in mind that many correct answers would be there for each problem, so you should not think that a particular answer is right and others are wrong. Only your thinking from different angles is required. This is not a test or an examination but a training. We shall work
together for almost 2 months; so please be honest in your work. Do not try to cheat or copy but write as many answers as you can for each item in your answer booklet."

**Period 1**

Multipresponse programme was started with the practice item of Arithmetic. Initially they were allowed to answer orally for the practice item. The whole class was stimulated to think and work by oral discussion. Then they were allowed to write on the 1st page of the booklet as many responses of the practice item as they could, during 2 minutes. After that they were made to stop for one minute. Then again they were allowed to write the responses of the same item for 3 minutes on the same page. The practice item being over, they were given the 1st item of the programme i.e. Arithmetical item. The investigator announced the item loudly so that the students could write it on the 2nd page. Thereafter they were allowed to give various responses at 3 stages as explained in 4.1.1 page. The work was found to be a little difficult in this period because the students were not accustomed to such work.

This item was finished within 18-20 minutes. Thereafter they were supplied 2 trace papers to work for Hidden shapes programme just at the end of the 1st item of Multi-
response programme. When they were writing their names, standards and roll numbers on the trace papers, the xerox copy of the practice item was supplied to everybody. The investigator drew some sketches on the trace paper with the names of the shapes in such a way that each of the students can see it. They were allowed to find out some other shapes in the same fashion, during 2 minutes. They were requested then to stop and show their work. With so much information they were encouraged for the hidden shapes programme. Thereafter the students were supplied a xerox copy of the 1st item of the programme and allowed to give responses at the 3 stages on the 2nd trace paper. This type of work was found to be more interesting than previous programme. At the end of the period the answer booklets and trace papers were collected along with xerox copies of the practice item and the 1st item.

Period 2

In this period the work was started with the 2nd item of multi-response type. As the 1st item was from Arithmetic, this time it was a Geometrical one. The item was finished within 12 minutes, as they were familiar with the work. Immediately the make-up problems programme was started. Information was written on a roll-up board. For
this programme the students were informed to start work from the last page of the same answer booklet. The investigator read the information of the practice item loudly. They were made familiar with this type of work by giving 2-3 illustrations of the responses on the black board. Thereafter the students were persuaded to prepare such questions and write in all the 3 categories for 4 minutes. By the time the other roll-up board, on which the 1st item was already written, was opened. The 1st item was so prepared that it demonstrated the importance of self help. After checking the practice item, they were allowed to write on the next (the last but one) page of the answer booklet. The investigator read the information with necessary explanations twice. Then they were asked to give the responses at 3 stages as explained in 4.1.3 page no. 63. Answer booklets were collected at the end of the period.

The information given in the item, being in the form of a story was found to be interesting by the students. Question formation was, however, found to be hard at both the levels.

Period 3

The students gave various and numerous responses of the 3rd item of the Multi-response type. This time the item
FLOW CHART

PASSI TEST OF CREATIVITY (P.T.C.)
PRE TEST

EXPERIMENTAL
GROUP STUDENTS
TOTAL - 181

PROGRAMME
WITH FEED-BACK
VII A 45
VIII A 46
TOTAL 91

PROGRAMME
WITHOUT FEED-
BACK
VII B 42
VIII B 48
TOTAL 90

CONTROL GROUP
STUDENTS
VII C 43
VIII C 47
TOTAL 90

DIVERGENT
THINKING
PROGRAMME IN
MATHEMATICS.

OPINIONNAIIE

P.T.C. POST TEST
DATA
selected was an Algebraic one. They wrote in on the 4th page of the answer booklet. Similarly the students were ready to work on the Hidden shapes item. Some of the students had to be supplied another trace paper. It can be considered as a proof of their interest towards the programme. The answer booklets and trace papers were collected along with the xerox copy of item 2 at the end of the period.

**Period 4**

The students wrote the 4th item of the Multi-response programme on the 5th page. Item selected was an Arithmetic one. They were then asked to read item 2 of the make-up problems programme, written on the roll-up board. For this item also the value of discipline in life i.e. punctuality in time is formed the gist of the item. Responses from the students were not so numerous as in the case of the Multi-response type items, but their responses were more in comparison with the 1st item of this programme. At the end of the period, the answer booklets were taken back.

**Period 5**

The students were found to be enthusiastic for the Multi-response item. This time the item selected was a Geometrical one. They were able to complete their work within 10-12 minutes. Thereafter the last item of the Hidden shapes
programme was started. The students were supplied a trace paper along with a xerox copy of the 3rd item. This type of work was known to them, so it was easy for them to finish all the three stages. The answer booklets, trace papers and the xerox copies of the 3rd item were submitted by the students at the end of the period.

**Period 6**

This was the last period for the training. The students were given an Algebraic item of the Multi-response type programme. It was given at three stages as the above 5 items. Then the 3rd item of the Make-up problems programme was put on the roll-up board. The students were asked to read silently along with the investigator reading it aloud. This item gave emphasis on co-curricular activity like spontaneous speech. Necessary explanations were given by the investigator while reading. This time the students gave more and correct responses of the item as compared with the previous 2 items. It proves that this type of work i.e. the Make-up problems programme was found to be hard by the students of the Std. VIIth and the VIIIth. At the end of the period all the answer booklets were returned by the students.
After the training of 1½ months, the students of the total sample were given the PTC in the next week of the last period. It was a post-test, given in the same way as the pre-test.

From an educational point of view it is necessary to give a questionnaire or an opinionnaire regarding the test or programme, just within a fortnight. Owing to some administrative and technical difficulties, the investigator was obliged to delay the follow-up work for three months.

The opinionnaire was given separately to all the 4 classes of the experiment. Only 10-15 minutes were required to complete it for each class. Thus within 2 periods the follow-up work was completed.

5.3.2 **Response Analysis**

The programme was not to be standardised at this level. So the response analysis should not be based on statistical calculations like reliability, validity or norms establishment. This programme was meant for the creativity development. Due to this reason it was necessary to analyse the responses according to the levels of
creativity. As per suggestions of B.K. Passi\(^9\), the responses less than 10% were to be considered as highly creative and the responses having percentage between 11% to 28% were called normally creative or common responses. Considering this suggestion as a guide line, the responses of all the items were classified into three categories as under:

1. 0 to 10% responses  
   Highly creative

2. 11% to 28% responses  
   Creative

3. Above 28% responses  
   Non-creative

The responses of the last i.e. III category, were neglected for all the 3 types of the programmes and the responses of the 1st and 2nd categories were listed as shown in Appendix III.

5.3.3 Observations

The following important observations were deduced from implementation of the programme. When the 1st type of programme i.e. Multi-response programme was applied to the VII and VIII graders, it was noticed that generally male students gave uncommon and intelligent responses throughout the programme.

---

As there was free atmosphere for the treatment group students, some so called naughty or mischievous students gave unexpectedly very good responses during the training programme. Moreover some students, who were found idle in the beginning of the time limit, proved quite creative and outstanding in their responses at the end.

Generally female students did not participate in the discussion during the training imparted in the interval between two writing time limits which misled the investigator into the impression that they were less creative. After the completion of some items, however, very good rapport was established with the researcher and various cum numerous responses were obtained from them. It followed that shyness natural to the girls of this age group was responsible for non-participation in the discussion.

Type II i.e. Hidden shapes programme proved to be very interesting and creative too in respect of all the students of both the grades.

Type III i.e. Make-up problems programme was found to be a little tough and confusing, to many a student and they developed a kind of aversion for this type of programme. Some really brilliant students, however, could give creative responses.