CHAPTER 4
DEVELOPMENT OF TOOLS

This chapter is devoted to discuss the development and standardization of tools used in the present study. There were two categories of tools—one were instructional tools and others were measuring tools. Whereas the purpose of measuring tool is to measure the existing capability of a person, the treatment tools are prepared in order to impart some instructions and to provide some treatment so as to develop a particular ability in a person. The treatment tool in the present study included Lesson Plan Format and the Worksheet. The measuring tools developed were: Concept map performance test for quantitative and qualitative analysis and Semi-structured interviews along with Case studies besides three approaches (analysis of structural change in knowledge, expert terms used, analysis of conceptual richness) for qualitative analysis. The process of tools construction has been described under the headings-Treatment tools and Measuring tools.

4.1.0 TREATMENT TOOLS

These tools were used to impart instructions as per the treatment concerned. Keeping in view the objectives and design of the study, two treatments were used viz., Creativity training program and Conventional method. For each of the two instructional variations, tools consisted of lesson plan formats and worksheet.

4.1.1 LESSON PLAN FORMATS

It consisted of arrangement of instructional elements in a sequence. In other words, it projected design of the lesson plan format so as to adhere to the intricacies of the teaching methods as per its assumptions, objectives and syntax, etc. For each of the treatment procedure, one lesson plan format was prepared. In all, two lesson plan formats were prepared—one for imparting instructions in creativity training and other for traditional method of teaching. The main purpose of these lesson plan formats was to prepare the lesson plans on the guidelines of the format. The process of construction of these lesson plan formats has been explained in the following paragraphs.
(i) Lesson plan format for Creativity Training Method

As in the present study Bono’s CoRT Thinking Lessons have been employed to impart instructions in the creativity training, therefore, the lessons plan format was prepared according to the guidelines provided by Edward De Bono in his training material provided in the form of CD. The lessons were adopted according to Indian situations. For preparing the lesson plan format, it was of utmost importance to list all the activities as per the tools mentioned (such as PMI, AGO, C&S etc.) that investigator wanted to apply in her training program. De Bono has provided a sequence of model lesson for how to run it in the class. The sequence is as follows:

- Do not mention the subject of the lesson, but start with a story or an exercise which illustrates the aspect of thinking that is the subject of the lesson.
- Introduce the TOOL or SUBJECT of the lesson and explain simply what it does. You can use the introduction in the student’s notes (provided in the CD).
- Carry out an open class example by setting a task and asking for individual responses. Repeat the letters of the tool or the subject as often as you can.
- Divide the class into groups of 4, 5 or 6. Set a practice item from the student’s notes. Allow about three minutes or the time specified.
- Get feedback from the groups, for example by getting one suggestion from each of the groups.
- Repeat the thinking with another item. Repeat practice items in this manner. Allow time to discuss the process of the lesson.
- Use the principles given in the student’s notes to have a discussion around the tool or subject of the lesson. If this discussion is weak, plug in a final practice item.
- If it is customary to give homework, use one of the project items for this purpose.

The standard lesson format included identification information, educational objectives, introduction, practice items, process, principals and follow-up exercises.

a) First of all, the lesson format started with the formulation of identification information concerned with the teacher such as: teacher’s name, the class to which the instruction was imparted, subject, topic, date, etc.
b) The second part was to formulate the educational objectives regarding the tools used in that particular training session. Moreover, meaningful clustering of the tools had been done for the purpose of making the lesson interesting as well as to keep the lesson structure tight so that the students did not feel bore or monotony in the environment.

c) The third part dealt with the introduction of the tool to be used. The teacher briefly explained the basic theme of the tool that centred on an example. Some more examples have been added as per the situation in the class.

d) After this, practice items were added to the lesson plan for practice by the students. At this time, the output from the students should be verbal. It was done to know the direction in which students were thinking and also to make students know where they were wrong.

e) Next section of lesson plan was called ‘process’ as it dealt with when, why and how of tool presented in the lesson. This part emphasized the importance of tool to be practiced by the students because it was the tool which was the main focus of lesson plan and not the practice items. Practice items were just to tell that how a tool was to be used.

f) In ‘principle’ section of lesson plan, there was a series of principles on which the tool worked. The groups can be made to look at the list of principles and encouraged if they wanted to add new principle.

g) After this section, there is a ‘follow-up’ section that includes exercise questions for follow up purpose. This section makes students work individually and clear their doubts, if any.

(ii) Lesson Plan Format for Expositional Method:

This format was designed according to the requirements and assumptions of this method. First of all, before the construction of format, all the activities of this method were listed and then these activities were divided into four components of this method. The first part was to formulate the identification information concerned with the teachers such as teacher’s name, the class to which the instruction was given, subject, topic, date, etc.
The second part was to formulate the educational objectives that were divided into two sub-parts- one is general educational objectives and the other is specific behavioral objectives.

The third part was constructed to formulate main part of the treatment, called as ‘Working exercise’ of this method. This part was also sub-divided into two sub-parts. One was concerned with teacher’s role and second was concerned with student’s role. The main purpose of this part was to identify the role of the teacher and the students during the treatment.

The fourth part was called as ‘Exposition to present condition’. Its objective was to formulate the expository format to the problem. This part was further divided into two sub-parts- one was concerned with the major points that were to be discussed during the experimentation. Other part was designed to evaluate the concept maps prepared by the students after the experiment.

**Editing and reviewing of the lesson plan formats**

After constructing the lesson plan format decided for both treatment groups, the next step was editing of the lesson plan format. Editing was considered good as it helped in knocking the rough edges off and polishing the material. The lesson plan formats were edited for three times. The first editing was done by a subject – matter expert to ensure the information accuracy of the lesson plan formats. The second editing was done by the lesson plan writing expert, who attempted to simplify the process of development of lesson and to discover the errors, if any regarding the presentation technique. The third editing was done by the language expert avoiding the literary discrepancies. The items which were having ambiguous languages were either modified or discarded. The first draft of lesson plan format was reviewed in the light of editor’s suggestions and then put in to try out phase.

**Try out**

The lesson plans were prepared for both the treatments on the basis of these lesson plan formats. These were then tried out in the class room situation. The purpose was to find out inadequacies and then to eliminate them from the lesson plan formats.
These improved and modified lesson plan formats were used for preparing the lesson plans for experimentation. Copy of these lesson plan formats have been given in Appendix.

4.1.2 WORKSHEETS

It is a record sheet used by the students during instructional process. The purpose of constructing the worksheets was to record information that originated as a consequence of classroom interaction along with the name of pupil, the teacher, the date of session, subject, topic, etc. The second purpose was to help students whenever they wished to review the points raised during discussion.

As had already mentioned, the procedure of imparting instructions in both the treatments was different. So, the format of the worksheet was also different. For each of the treatment procedure, format of worksheets was prepared.

(a) Preparation of worksheets

Each worksheet was having four major parts i.e. identification information, information about the topic, practice exercises and re-examination of original task.

(i) Identification information: This part was meant for the identification information such as name of the students, the date of the session, class, subject, topic, etc.

(ii) Information about the topic: The second part of the worksheet was to record the information such about the topic which the students already knew before starting the experimentation.

(iii) Practicing exercises: this part of the worksheet was meant for different steps to be followed in each of the treatment procedures applied. Therefore, this part was sub-divided according to the steps or phases followed in the treatment procedure.

(iv) Re-examination of the original task: The fourth part called as ‘re-examination of original task’ was meant for reviewing the topic after the treatment and penning down the same.

(b) Editing of the worksheet

After preparing the worksheets for both the treatment groups, these were reviewed from the view of language. Ambiguous items were modified according to the
recommendations of the language expert. After this, the worksheets were given to the expert of strategy wherever he pointed out mistakes in sequencing of the steps. His suggestions were duly incorporated in the worksheets. These modified and improved worksheets were used. Different worksheets, developed and applied in the study, have been given in appendix-

4.2.0 MEASURING TOOLS

As already specified, the measuring tools included the Concept map performance test (criterion concept map), General Mental Ability Test, Socio-economic Status Scale, Semi-structured interview.

4.2.1.0 CONCEPT MAP PERFORMANCE TEST (CRITERION CONCEPT MAP)

This test has been devised to measure meaningful learning, creative thinking and understanding of the students of grade IX and X (separately for each grade level) regarding content matter in the form of list of ‘concepts’. The students are required to design a concept map from the list of concepts provided to them. The test permits freedom of the responses to the students. Therefore, creative thinking of students is the base of this test. More the student is creative; more complex will be his concept map.

As the test was also new one, therefore, the students were provided orientation in this technique. The subjects were supposed to answer a focus question in the form of concept map. For this purpose a list of concepts had been given to the students. The students were asked to design the concept map from the list of ‘concepts’ provided in the worksheet as per their understanding of the focus question. All the items were verbal and, therefore, could be administered in group or individually. Though there was no time limit for the test, investigator observed (during various trials and experiment) that the maximum time taken by the subjects was twenty-five minutes. But extra ten minutes were also given to complete the test. The instructions were also provided before the actual administration of the test.

Various studies in abroad and in India have centered the scoring of the test around various components of concept map. With no previous studies to make a lead, the investigator focused the scoring on four elements of concept map. The elements
considered necessary for the present study were: propositions, example, hierarchy and cross-links. Propositions and examples indicate the appropriateness and misconceptions held by the learner for a specific subject matter. Hierarchy indicates the various meanings of a ‘concept’ held by the learner. More the levels of hierarchy more will be the connections to that particular ‘concepts’. Cross-links indicate the new meaning and new knowledge acquired by the learner about the concept map other than that exist commonly. The subjects were supposed to be sharp and crisp, giving to the point answer according to the prescribed direction.

To find the effect of creativity training program on concept map performance, the investigator prepared and standardized the concept map performance test i.e. criterion concept maps and worksheets separately for both grade levels IX as well as X. The following steps were followed while developing and standardizing the criterion concept maps of both the grades:

(a) Preparation of preliminary draft
(b) Standardization of the criterion concept map

4.2.1.1 Preparation of preliminary draft:

Preparation of a preliminary draft was cumbersome process of the study. After much observation from the literature and discussion with the experts, the investigator found out that formal steps of preparing preliminary draft of any measuring tool that prevail most commonly in any research methodology are not employed while preparing the blue print of preliminary draft of concept maps. Therefore, In order to create standardized concept maps for the present study, the investigator has modified the steps accordingly. These are as follows:

(a) Item Formulation:

It involves the formulation of items for preparing preliminary draft. Here, in the present study item formulation was related to formulation of list of concepts and a focus question. For this purpose, this step has been divided in to further two sub steps. These are:
• **Selection of the topic:**

The investigator herself chose lessons from text books of environmental science of grade IX & X from the syllabus as prescribed by NCERT. The topics were also chosen to be used as training material for the concept mapping technique as well for preparing concept maps.

• **Discussion with experts:**

Further, the investigator scheduled a meeting with the subject experts in the subject of science. All were experienced teachers. They were told about the purpose of study and have been provided information about concept mapping technique. As it is a new technique in India, it was not possible for the investigator to find out the expert in the nearby locality. Much of the discussion has been done with Ms Meena Kharatmal, an expert in Concept Mapping Technique and is currently working in TIFR-Tata Institute of Fundamental Research, Pune, Maharashtra through email. But the subject expert teachers were also consulted for the purpose of selection of concepts as per the focus question set forth to accommodate the school environment and culture. During the discussion, from the texts, the focus questions were identified and the key concepts were selected.

Thus the items were formulated from different sources like relevant literature and discussion with the experts in the field of concept mapping. Some help was also taken from internet. In this way a list of 22 items were prepared initially. All these items were framed in such a way that the different items may provoke creative thinking of examinee holistically.

**(b) Item selection:**

This step again involves two sub steps. These are as follows:

• **Try out:**
For this purpose, both the subject experts and the investigator were taken into consideration. They constructed the criterion concept maps individually by using the key concepts to answer the focus questions. Then, the criterion maps were scored by the investigator and the teachers who have been trained by the investigator for scoring the concept maps. Each map was given a total point score based upon the assigned criteria. After scoring the maps, the teacher experts and the investigator discussed the flaws found regarding the list of concepts, misconception held by the students about any specific concept and addition or deletion of any specific concept that may enhance / reduce the complexity of concept map or misunderstood by the students.

- **Editing and reviewing:**

  The list of concepts as well as the focus question, thus prepared, were carefully edited and reviewed for content relevance and learning outcomes as well as technical accuracy and language. The help of subject matter expert was taken at this stage. Directions were written down; the suggestions were noted down and the modifications have been done accordingly. In this way, list of items so prepared was reviewed. The items which were overlapping or repeated were dropped out. The items which were ambiguous or wrong language were modified or dropped altogether. In this procedure, six more items were dropped. Finally, the preliminary drafts of both criterion concept maps of both grade levels were satisfactorily developed. Ultimately the final drafts of concept maps were left with only 16 items in concept maps of both grade levels.

(c) **Item Analysis:**

Another important aspect in the construction of the test was item analysis. It is concerned eith the item difficulty and item discrimination. Item difficulty is taken in terms of proportions and item discrimination by individual, completing the item successfully. Discrimination index refers to the degree by which it differentiates between those obtaining higher and low value. But in the concept map performance test, the items were of divergent nature and there is no right or wrong answer. So, item difficulty cannot be measured exactly in conventional manner. Therefore, an idea of productivity of an
item i.e. its capability of generating adequate responses was taken into consideration. For this, items were adequately analyzed adequately in pre try out phase. Items were modified and substituted a number of times till they were found to be sufficiently productive and capable of producing adequate response. It was based upon the judgment of the investigator as well as the related competent persons. Viewpoints of the examinees during initial and try out stage were also duly incorporated. The final draft was further subjected to the process of validity and reliability.

4.2.1.2 Standardization of the Concept Map Performance Test

- **Reliability:** In order to establish inter-rater reliability of the criterion concept maps, independent raters (other than that who helped in preparing criterion concept maps) were asked to score the criterion map for the components chosen. A reliability measure was computed by calculating the percentage of agreement correlating the two independent rater’s scores - who were blind to the purpose of the study - with that of the investigator’s score. The scores of the two independent raters were calculated for reliability by adding the totals together and dividing by two. This number was divided by the total number obtained by the investigator with resulting number indicating the percentage of correlation (Borg and Gall, 1983). The inter-rater reliability was found to be 0.92 for IX grade and 0.93 for X grade.

- **Validity:** For the validity purpose face validity of the concept maps was taken into account. For this purpose the concept maps were given to the teachers in science subject and their comments were noted down. It was observed that the teachers were satisfied with the concepts provided for answering the focus question.

4.2.2 Interview

Qualitative evaluation of the concept map performance test required some face to face interaction with the student-teachers. To do the same interviews of six students were held. These students were selected on the basis of their post test scores. Two student-teachers who scored highest marks in test (one from each class) and two students who
scored lowest marks were chosen for the interview. Two student-teachers who gained highest i.e. the difference between post-test scores and pre-test scores of them was maximum, were also selected from each class. Semi-structured open ended interview was held. The exact wording and the sequence of questions were pre-decided. But the questions were worded in a completely open ended format. To keep the interview effective, great care was taken in developing the report. The initial task of securing the confidence and cooperation of subject was done with great sensitivity.

**Interview Structure**

The interview was framed in a semi-structured form and the questions and their sequence was predefined. Still every care was taken in bringing comfort and flexibility for the interviewee. The subjects were separated in a way that they might not get any chance of interaction with already interviewed candidate. They were convinced that the answers were quite confidential and will have no aftereffects on them, whatsoever. The observations were manually recorded. But main focus was kept on their emotions, reactions, anxiety or enthusiasm. The directions of their answers decided the further course of the interview. The views about the test and technique were confirmed in the end again.

- **Reliability:** the reliability or the consistency of the response was evaluated by restating a question in slightly different form at a later time in the interview. The questions of the interview were found to be sufficiently reliable and valid.
- **Validity:** To make the interview valid, the content validity was used. The critical judgment of the experts in the field of education and thinking was taken to select the essential questions.