CHAPTER - III

METHODOLOGY AND TOOL DEVELOPMENT
CHAPTER 3
METHODOLOGY AND TOOL DEVELOPMENT

3.0.0 INTRODUCTION

The rationale of the present study along with its objectives and hypothesis has been stated in chapter I. The second chapter was about review of related literature. The present chapter is devoted to the description of sample, design, tools, procedure of data collection and statistical techniques used for analyzing the data. The details in respect of each one of them are given here under different captions.

3.1.0 SAMPLE

The present study was experimental in nature and conducted in two stages. At the first stage, Self Instructional Material and tools were developed. The self-Instructional Material based on different steps of Identifying Pros/Cons Thinking Skill was also developed. The details of its development are given in a separate Chapter IV. These tools were Achievement Test, Thinking Skill of Identifying Pros/Cons test and Reaction scale. For developing these tools two sample were used. At the second stage, experiment was conducted on another sample, but the sample used at the two stages belonged to the same population. Details in respect of samples used at two stages are given below separately.

3.1.1 First Stage Sample

At the first stage various tools were developed. The very first tool was for measuring achievement. The achievement of the students was assessed with the help of Achievement Test developed by the investigator. The test comprised of questions from different topics of Science subject such as agriculture, health, diseases, air pollution,
water pollution, motion, green house effect, types of diseases, etc. For developing the Thinking Skill test different topics of Science along with different steps of IPC were included to design the test and all the norms for standardization were followed to standardise the Thinking Skill of Identifying Pros/Cons Test. The students' reaction towards Instructional Material was assessed with the help of Reaction Scale developed by the investigator. This scale comprised of 20 statements. The statements were related to various aspects of Instructional Material. Each statement had a five point rating scale.

For the development of Thinking Skill of Identifying Pros/Cons Test, two samples were used.

Sample A- The researcher developed Thinking Skill of Identifying Pros/Cons Test. For its standardization, sample were used in two parts, In part A 10 students from Section A of Green Field Public School were taken. They were given the test to read. They were asked for any writing and printing mistake. They were also asked whether they found any difficulty in understanding the questions? Was there any word having two meanings? etc. After obtaining their suggestions, appropriate changes were made by the researcher in the tool.

Sample B- For the second part of standardization 130 students were taken. Students of section B were taken from Green Field Public school, while students of section C & D were taken from New Father Angel Higher Secondary School. Both the schools were affiliated to M.P. Board, Bhopal. The medium of instruction was English. Most of the students of the school belonged to urban area and were having average and high socio economic status. Majority of the parents were engaged in their own business or services, so students had congenial environment for study at home. They got all types of academic help from their family members. The academic climate of the schools was good and the teacher paid much attention to the students. Apart from academics there were many co-curricular activities and from time to time students were also sent for participating in competition like debate, essay writing, drawing, music, dance, etc. The age of students ranged from thirteen to fifteen years. Their distribution is given in the following table 3.1.
3.1.2 Second Stage Sample

At the second stage, the experiment was conducted. For the purpose of experimentation, two sections of class ninth from the total four sections of New Father Angel Higher Secondary School, situated in Indore were selected randomly. All together there were eighty two students belonging to these two sections, section A and section B where Thinking Skill of Identifying Pros/Cons was taught along with other Science content. The section wise distribution of the sample is given in table 3.2.

Table 3.2: Section Wise Distribution of Sample for Second Stage

<table>
<thead>
<tr>
<th>School</th>
<th>Section A</th>
<th>Section B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Father Angel Higher</td>
<td>42</td>
<td>40</td>
<td>82</td>
</tr>
<tr>
<td>Higher Secondary School</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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From Table 3.2, it is clear that the second stage sample comprised of eighty two students of class ninth. The syllabus prescribed by M. P. Board, Bhopal was being followed. The school was situated in urban area, so the sample represented urban population only. Majority of the students belonged to average and high socio economic status. All the children’s parents were not so highly educated, but they were able to help their children in academic matters. Mostly in urban areas the academic climate is very congenial. The age of the students ranged from thirteen to fifteen years. The medium of instruction was English.

3.2.0 EXPERIMENTAL DESIGN

The present study was experimental in nature. The study was designed on the basis of Non-equivalent control group design. As per Campbell and Stanley (1963), the layout of the design is as follows:

\[
\begin{array}{c}
\text{O} & \text{X} & \text{O} \\
\text{----------} \\
\text{O} & \text{O}
\end{array}
\]

Where:

\(X\) - Treatment

\(O\) - Observation

From Table 3.2, it is evident that the sample for experimentation comprised of 42 Class Ninth (Section- A) students belonging to New Father Angel Higher Secondary School, Indore. The students of the selected school were randomly assigned the treatment. Before starting the treatment, the students of both the groups i.e. Experimental Group and Control Group were pre-tested by administering Achievement Test and Thinking Skill of IPC Test. The treatment given to the students constituted the pre-Achievement and pre-Thinking Skill of IPC course. After the administration of pre-test, the treatment was started. The control group studied through traditional method (lecture method) where
the experimental group was taught through Instructional Material. The different stages of Instructional Material were as follows:

Science subject covers a very large area; it has many sub subjects like Biology, Chemistry, Physics etc. From the Science textbook of Class Ninth some units selected were Is Matter around us Pure, Why do We Fall Ill, Motion, Natural Resources and Improvement in Food Resources. After selecting the units, different topics were selected for giving treatment to the experimental group. Some of these various topics were Health and Diseases, Industrialization, Animal Husbandry, Vermi-composting, Public cleanliness, Water pollution, Readymade food material etc. These topics were taught by using the steps of Thinking Skill of IPC. The lesson plans related to each of the selected topic were made. A sample of lesson plan comprising of Thinking Skill of IPC as mentioned above is given in Appendix - IV. For each topic there were more than four lesson plans involving their sub topics or examples. The topic wise distribution of lesson plan is given under Table 3.3.

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Unit Name</th>
<th>Topic</th>
<th>No. of Lesson Plans</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Why do We Fall Ill</td>
<td>I. Public cleanliness – classification of waste material.</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>II. Tour – during summer vacation we should go on a tour for social health.</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>III. Only balanced diet is enough for good health, no effect of environment.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IV. Individual Health- one should not waste one’s time in social gathering.</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>
| 2 | Improvement in Food Resources | V. Only good economic conditions are enough for good health. 4  
VI. Being disease free is a symbol of good health. 4  |
|  | I. Vermicompost should be used than chemical fertilizer. 4  
II. High amount of fertilizer is good for high crop production. 5  
III. Use of Pesticides should be banned in agriculture. 4  
IV. Nomenclature- should apply or not? 4  
V. Anima husbandry - Poultry farming should be banned. 4  |
| 3 | Natural Resources | I. Use of Poly bags should be banned. 4  
II. Water pollution- Do not use fertilizer and pesticides. 4  
III. Air pollution- Only public vehicles should be allowed on roads. 4  
IV. Human being is responsible for Green House Effect. 2  
V. Industries should be banned. 4  |
| 4 | Is Matter Around Us Pure | I. Readymade food materials. 4  
II. Growing vegetables in our garden is alternative to avoid diseases. 3  
III. Indian traditional system of serving 4  |

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| 5   | Motion           | I. We should use bicycle in place of motorbike.                      | 2 |
|     |                  | II. Playing games only is better way to explain motion.             | 5 |
| 6   | Other Relevant Topics | I. The classes of school should be held only for 5 days in a week. | 4 |
|     |                  | II. Frequent use of mineral water should be avoided.               | 3 |
|     |                  | III. Cutting of trees is required.                                 | 4 |
|     |                  | IV. Newspaper is a waste material.                                 | 4 |

Each day, the content covered in one lesson plan and other related exercises were taught to the experimental group and it continued for the period of 45 minutes to all working days. The total treatment duration was 5 months. When the students of experimental group were undergoing the treatment, the students of control group were taught the same topic with the help of lecture method. The duration of teaching for both experimental and control group was the same. In this way, all the selected topics were taught. At the end of the treatment, the same Achievement Test and Thinking Skill of IPC test, which were administered before the treatment were administered separately to the students of both the groups. In addition to these, the students of experimental group were also administered a Reaction Scale for finding students’ reaction towards Instructional Material at the end of
the treatment. The variable, namely, Intelligence of the student of both the group was assessed by administrating Verbal Intelligence Test developed by R. K. Ojha and K. Ray Chowdhary (1971). The Tolerance of Ambiguity of students was assessed with the help of Tolerance of Ambiguity Test developed by Dr. Smita Bhavalkar (1992). Self Confidence was measured by Self Confidence Inventory developed by Dr. Rekha Agnihotri in the year 1981. Baqar Mehndi (1973) test of Creativity was used for Creativity assessment. Personality of the students was assessed with the help of Maudsley Personality Inventory (MPI) (1972) originally developed by Eysenck and later adapted by Jalota and Kapoor for Indian population in Hindi and Punjabi language. For the assessment of Study Habits of students Study Habits Inventory developed by Dr. M. Mukhopadhyaya and Dr. D. N. Sanasanwal (1983) was used. The schematic representation of the experiment is given in Table 3.4.

Table 3.4: Schematic Representation of the Experiment

<table>
<thead>
<tr>
<th>Activity</th>
<th>Experimental Group</th>
<th>Control Group</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Formation</td>
<td>I. Sections were selected randomly but not the subject within each group.</td>
<td></td>
<td>45 min</td>
</tr>
<tr>
<td></td>
<td>II. Random assignment of treatment to section.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre testing of dependent variables.</td>
<td>I. Administration of Achievement Test.</td>
<td></td>
<td>90 min</td>
</tr>
<tr>
<td></td>
<td>II. Administration of Thinking Skill of Identifying Pros and Cons Test.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Testing of Covariates

I. Intelligence
II. Creativity
III. Self Confidence
IV. Study Habits
V. Personality
VI. Tolerance of Ambiguity

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Content was taught through Instructional Material based on Thinking Skill of Identifying Pros and Cons at all working days.</th>
<th>Content was taught through lecture method at all working days.</th>
<th>45 min (as per day)</th>
</tr>
</thead>
</table>

Post testing of dependent variables

I. Administration of Achievement Test.
II. Administration of Thinking Skill of Identifying Pros and Cons Test.
III. Administration of Reaction Scale to find out reactions of students towards Instructional Material (Experimental Group).

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing of Covariates</td>
<td>I. Intelligence</td>
<td>40 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>II. Creativity</td>
<td>35 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>III. Self Confidence</td>
<td>20 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV. Study Habits</td>
<td>15-20 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>V. Personality</td>
<td>15-20 min</td>
<td></td>
</tr>
<tr>
<td></td>
<td>VI. Tolerance of Ambiguity</td>
<td>30 min</td>
<td></td>
</tr>
</tbody>
</table>

3.3.0 TOOLS

The details of the tools used for measuring different variables in the present study are given in Table 3.5.
Table 3.5: Description of the Tools

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Tool</th>
<th>Developed By</th>
<th>Status</th>
<th>Reliability</th>
<th>Validity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Achievement Test</td>
<td>Researcher</td>
<td>Self Developed</td>
<td>Not Established</td>
<td>Not Established</td>
</tr>
<tr>
<td>2</td>
<td>Thinking Skill of IPC Test</td>
<td>Researcher</td>
<td>Self Developed</td>
<td>0.90</td>
<td>Content and Face Validity</td>
</tr>
<tr>
<td>3</td>
<td>Verbal Intelligence Test</td>
<td>R. K. Ojha and K. Ray Chowdhary (1971)</td>
<td>Standardised</td>
<td>0.91</td>
<td>0.574</td>
</tr>
<tr>
<td>4</td>
<td>Creativity Test</td>
<td>Baqar Mehndi (1973)</td>
<td>Standardised</td>
<td>0.946</td>
<td>0.385</td>
</tr>
<tr>
<td>5</td>
<td>Maudsley's Personality Inventory</td>
<td>H.J. Eyser.ck (1972)</td>
<td>Standardised</td>
<td>0.567</td>
<td>Not Available</td>
</tr>
<tr>
<td>6</td>
<td>Self-confidence Inventory</td>
<td>Dr. Rekha Agnihotri (1987)</td>
<td>Standardised</td>
<td>0.95</td>
<td>0.82</td>
</tr>
</tbody>
</table>
As evident from Table 3.5 in the present study, the tools used for collecting data were Intelligence, Self Confidence Inventory, Tolerance of Ambiguity, Study Habits, Personality, Creativity, Achievement Test, Thinking Skill of IPC test and the Reaction Scale for measuring the reaction of students towards the Instructional Material. The data pertaining to the variables, Intelligence, Self-confidence, Study Habits, Creativity, Tolerance of Ambiguity and Personality were collected with the help of already available standardized tools and on the other hand, Achievement Test in Science, Thinking Skill of IPC Test and Reaction of the student towards Instructional Material were assessed with the help of the tools developed by the investigator. All these tools were administered on the total sample of 82 students, while the Reaction Scale towards Instructional Material was administered only on the Experimental group i.e. Of 42 students. In this chapter, all the technical details related to the development of tool are given. During the process of development of Achievement Test in Science, the steps followed were

i) Planning for developing test

ii) Listing objectives and specifications
iii) Preparation of test  
iv) Discussion with the experts in the field of test construction of Science teaching. 
These are given under following captions.

3.3.1 Achievement Test

The scholastic achievement, popularly known as Achievement was one of the variables in the study. Achievement Test, as the name signifies, is employed for measuring the amount of success or achievement of an individual in a specific field/area of accomplishment. It is essentially a tool or device that helps in ascertaining quantity and quality of learning attained in a subject of study or a group of subjects after a period of instructions by measuring the present ability of the individual concerned. According to Webster’s dictionary (1989) “Achievement means, something accomplished especially by superior ability, special efforts, great valor etc. It is Accomplishment, or proficiency, or performance in a given skill. Achievement is theoretically different from Intelligence but, overlaps with it to a great degree.”

For assessing the achievement of students, Achievement Test was developed by the investigator. This test comprised of different topics of Science such as health, diseases, pollution, motion etc. Different items were included by following various steps. The investigator studied thoroughly the curriculum, syllabus and text-books of Science prescribed for standard IX pupils and other relevant books of Science and selected units from the standard IX Science in particular. After analysing the content of the units, the investigator selected content for the development of the test. For this purpose the investigator had also taken the help of experts involved in teaching Science and the ideas and responses of the students related with the items were also collected. The test items comprised of fill in the blanks, match the column, true/false, multiple choices, one word answer, select the odd one, short answers etc. The distribution of marks with the items is given in Table 3.6.
Table 3.6 Distribution of Items with their Marks

<table>
<thead>
<tr>
<th>Test</th>
<th>Type of Question</th>
<th>Number of sub' questions</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement Test</td>
<td>Multiple choice questions</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Fill in the Blanks</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Write one word</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Match the Column</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Short Answer Type Questions</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Select and Mark the Odd One</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>True/False</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
<td><strong>45</strong></td>
<td><strong>50</strong></td>
</tr>
</tbody>
</table>

Thus it is evident from the Table 3.6 that Achievement Test consisted of 45 questions. These questions were constructed from the selected units of IX Science syllabus. The duration of test was 90 minutes and students completed it within the given time. Total marks of the test were 50. The scoring of the test was done as per scoring key developed by investigator. The marks awarded for each correct answer were not equal. Achievement Test is given in Appendix - I.
Another dependent variable of the present study was Thinking Skill of IPC. As human being is superior to all other beings and considered to be the greatest creation of God, this superiority is due to his superior ability to think. To improve the power of thinking over the years, thinking has been divided into many sub skills Identifying Pros and Cons (IPC) is one of the important skills of thinking and prerequisite for many activities in the curriculum like concept formation and concept attainment etc. Many underlying skill such as thinking, memory, organization, note-taking and analyzing etc. also depend on the ability to compare and categories efficiently.

A thinking process is a relatively complex sequence of Thinking Skills. Some time consuming Cognitive operations such as Concept formation, Problem solving, and Composing, all of which employ one or more core Thinking Skills come under thinking process. According to Gilmer(1970), “Thinking is a Problem solving process in which we use ideas or symbols in place of overt activity.” Thinking is a series of symbolic processes. It makes use of symbols, precepts, images and concepts. The symbols either represent or stand for objects or events in the environment. Images are either sensory or verbal. Therefore thinking involves representative process.

The skill entitled as Identifying the Pros/Cons (IPC) is a skill to judge the positive and negative attributes of a given concept or idea. IPC has 3 words involved in its body. They are (a) Identifying (b) Pros and (c) Cons.

- The word ‘Identifying’ carries connotation like recognizing, labeling, discriminating, demarcating and so on. These have their special meaning but we have derived the use of all other terms accept the one chosen for the same.

- The word ‘Pros’ is not actually a dictionary word. As a matter of fact Pros and Cons are used as proverb or one phrase. Here the clarity of the
meaning of pros is carried out by the words like strength, favor, profit, positivity, inside, goodness etc. Actually speaking these words have their own meanings, but the list of all these words will be able to make the sense clear.

➢ The word ‘Cons’ also is not a dictionary word. It is always used with the word Pros to make a phrase Pros and Cons. To get an overall impression we can use the words like weakness, loss, against, negatives, badness, limitations and outside. Of course these words have their own meaning but here we avoid the use of other terms accept the one chosen for the purpose. ‘Cons’ is also used for consequences.

This micro skill is a process having a series of steps for mental development of a child. These steps are as follows.

ix. **Identification of the statement/concept:** This step is the beginning of thinking skill of IPC. The teacher will give the statement or the topic selected to debate.

x. **Listing the statements showing strengths and opportunities of the concept:** In this stage the teacher will ask his students to think about all the positivity present in the concept. The teacher will allow his students to think about good ideas, to list them out mentally and then they will be allowed to write them down into their notebooks without any discussion.

xi. **Listing the statements showing weaknesses and threats of the concept:** This step is similar to the above step but here the teacher asks the students to make a list of weaknesses present in the concept. Students arrange them in the list in their notebooks.
xii. **Selecting the more applicable sentences for the statement/concept:** Now students select the more applicable sentences from the list which are having heavy impact or the sentences showing more strength.

xiii. **Selecting the more harmful sentences for the statement/concept:** After the strong positive sentences, students are asked to select most hazardous sentences from the second list of negative sentences in the same way as previous step.

xiv. **Finding arguments for the selected sentences in favor of the concept:** This step requires more live support from the students. Teacher is like a passive listener. The teacher gives a list of selected sentences which gives strength to the statements. The students give logical justification to the selected sentences one by one.

xv. **Finding the arguments for the selected sentences against the given concept:** This step is similar to the above step. The teacher will show the second list of harmful sentences and ask the students for their justifications. That justification must be based upon the logical arguments.

xvi. **Drawing the boundaries by specifying for the judgment:** This step is essential for making the process of Identifying Pros/Cons complete. Student thinks properly or step by step to get best solution of the situation or a problem. They draw boundaries on the basis of effect of selected sentences on the statement.

The entire IPC task requires the identification of attributes sorting into categories according to these steps. Studies show that students have difficulty in taking decision when the same data is presented in different way (Kerslaak, 1981, Bright and Friel, 1998). To address this problem, teachers should provide students with numerous opportunities “to compare multiple representation of the same data set” and engage
students in “rich discourse on what each of the representation shows (Bright and Friel, 1998). Students who develop Sorting and IPC skill during kindergarten and elementary level (along with related skill such as Problem solving) are significantly more likely than their peers to succeed academically through secondary school (Dudek, Stoebel and Thomas, 1987; Siliphant, 1983). Teachers can help students to develop IPC skill by giving them opportunity to think and practice with wide variety of objects and situations. From the foregoing description, it is evident that Thinking Skill of IPC refers to the higher level Thinking Skills which constitute cognitive domain. Bloom’s taxonomy (1956) is a model for conceptualizing higher level Thinking Skill. It is a classification of thinking with six different levels with each successive level increasing in complexity. The first three levels knowledge, comprehension and application are often referred to as lower level thinking while the next three levels analysis, synthesis and evaluation are referred to as higher level thinking.

Generally it is observed that our education system is built in such a way that it is putting much emphasis on the development of abilities related to lower level thinking and rest of the levels are either totally neglected or their application is very limited. In other words one can say that development of higher level Thinking Skills remain always untouched mostly at secondary level and when the students reach to higher level, they find it difficult to cope up with problems related to analysis and synthesis level. The reason behind this may be the use of traditional method, which discourages students to think in an innovative way, vastness of content, faulty designed curriculum and lack of time. This encourages students for rote memorization.

Thus in the present study an attempt has been made for developing Thinking Skill of IPC through the use of Instructional Material developed by the researcher. As thinking is a new area and very few aspects of it are researched upon. At present no tool is available for measuring Thinking Skill of IPC by taking Science as a subject for class IX students. To fill this gap it was decided to develop this tool to measure Thinking Skill of IPC. During the process of tool development the steps followed are given in figure 3.1.
Figure 3.1 Steps of Tool Development

Planning for developing test

Listing objectives and specification

Preparation of Preliminary draft

Preparation of pool of multiple items

Selection of items from the pool of items

Preparation of first draft

Discussion of the first draft with experts

Selection and modification of test items from the first draft

Preparation of the second draft

Try out of the second draft of the test

Item analysis

Final draft
Construction of the Thinking Skill of IPC Test

Establishing Reliability and Validity

These steps are described in detail as follows:

**Step I : Planning for developing Thinking Skill of IPC Test**

The advancement, technological, scientific and cultural progress of human race totally depends upon the cognitive development of an individual, which happens to be the sole aim of our education. How individually, creatively, critically an individual analyses anything and form decision. These all are the products of his smart thinking. He thinks, plans and puts them into action. There are various ways which facilitate thinking. Thinking Skill of IPC is one of the skills of thinking and an important aspect of cognitive domain Thinking Skill of IPC helps to discover relationship that gives meaning and order to things and improves learning and communication. It develops amongst the students the ability to arrange or sort out objects and situations into various groups on the basis of their pros and cons. This helps students to learn effectively and in a logical way, thus solves the problem of all walks of life. This skill also facilitates the process of concept formation because in it also concepts are formed on the basis of categorization. The above mentioned reasons were considered as the basis for the development of Thinking Skill of IPC test.

**Step II : Preliminary Draft**

The reasons given in Step I were the basis for the development of Thinking Skill of IPC Test. In order to avoid the drawbacks of the teacher made test such as ambiguous questions, excessive wording, lack of appropriate format a systematic procedure of test construction was adopted.
For collecting and developing items for tool two approaches could be followed. One approach was that items could be selected from different books of Science or other relevant books. Other approach may be by taking the help of experts in the field of Science teaching. In the present study both the approaches were adopted for developing the items for tool. At this stage the suggestions, innovative ideas and responses of students related with items were also collected. In this way involvement of teachers, experts, books, pupils and peers were taken to avoid drawbacks.

It was decided to have the items as mentioned earlier taken from all the levels of Cognitive domain as referred by Bloom (1974) i.e. knowledge, comprehension, application, analysis, synthesis and evaluation. While writing the items the types of items was not the main criterion to be followed but the point to be kept in mind was whether the item measured the aspect of Thinking Skill of IPC or not. Match the column, odd word out, fill in the blanks with suitable words etc were included in the test. During the process of test construction different Science books, experienced Science teachers, pupils and teacher educators were consulted to judge the quality of the test. The items were considered on the basis of the following factors to test the desired achievement in the fields selected.

- Relevance: The questions of the tests were selected judiciously to test the desired achievement in the fields selected.
- Balance: The investigator tried to maintain the balance in all the topics selected as expressed in the specification of the test.
- Efficiency: While preparing the test two factors were taken into account. Firstly, efficient use of time for grading and secondly efficient use of students' limited time in the test period.
- Objectivity: The questions were made clear and answers were definite enough so that any student, in the field covered by the test, would get a perfect or near perfect score.
Specificity: The test gave some chance of scoring even to those who have not studied the content but are intelligent as they could answer the questions of the selected portion.

Difficulty: The test items and the whole test was considered on the - difficulty level, it was meant to be neither too difficult nor too easy to function efficiently with the examinees for whom the test was intended.

Discrimination: Few individual questions which discriminated sharply between high achievers and low achievers were selected. The test as a whole yielded a wide distribution of scores for students who differed in achievement.

Authenticity: The test was developed on the MP Board pattern and was similar to the tests which students get.

Fairness: The test tried to give each student a good and equal chance to demonstrate his real achievement in the area covered by the test.

Speed: The test was appropriate in length for available time as 90% of the students completed the test.

By adopting this process twenty-five items were written. These items and format were scrutinized by experts in the field of test construction in English teaching. The experts were also briefed about Thinking Skill of IPC. The experts were requested to see whether the items could measure the IPC skill of class IX students. After writing the first draft, it was given to experts from the field of Psychology, Science teaching and Testing. In the light of experts’ Suggestions, 10 items were dropped and some items were restructured. Thus, from the pool of 25 items, the test finally consisted of 15 items.

Step III : Preliminary Try Out

The modified Thinking Skill of IPC test consisting of 15 items was administered to 130 students of class IX. Before starting the test the students were given clear instructions as to how to proceed and answer the test. They were given clear instructions to read each item carefully, select and write appropriate answer. They were told to begin the test. The time limit to complete the test was 90 minutes. On an average
students completed the test within the prescribed time. As soon as the students finished responding, the test answer-sheets were collected. The scoring was done with the help of key developed by the investigator. The item wise scoring scheme is given in Table 3.7.

Table 3.7: Item wise Scoring Scheme

<table>
<thead>
<tr>
<th>Item</th>
<th>Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2%</td>
</tr>
<tr>
<td>2</td>
<td>02</td>
</tr>
<tr>
<td>3</td>
<td>05</td>
</tr>
<tr>
<td>4</td>
<td>2%</td>
</tr>
<tr>
<td>5</td>
<td>02</td>
</tr>
<tr>
<td>6</td>
<td>05</td>
</tr>
<tr>
<td>7</td>
<td>2%</td>
</tr>
<tr>
<td>8</td>
<td>2%</td>
</tr>
<tr>
<td>9</td>
<td>05</td>
</tr>
<tr>
<td>10</td>
<td>09</td>
</tr>
<tr>
<td>11</td>
<td>2%</td>
</tr>
<tr>
<td>12</td>
<td>2%</td>
</tr>
<tr>
<td>13</td>
<td>2%</td>
</tr>
<tr>
<td>14</td>
<td>2'%</td>
</tr>
<tr>
<td>15</td>
<td>02</td>
</tr>
</tbody>
</table>

The data obtained from this tryout were used for the purpose of item analysis.

Step IV: Item Analysis

The main objective of item analysis was to select items from those included in the preliminary draft. The criterion for selection of items was discrimination index. The obtained scores were arranged in descending order. From the list of the scores which were arranged in the descending order, the scores belonging to the upper 27% (20) and lower 27% (24) were identified. The mean Thinking Skill of IPC scores at the groups were compared with the help of t-test. The significant t-value
item discriminated between the mean Thinking Skill of IPC scores of these two extreme groups i.e. the upper and the lower groups. Therefore the items having significant t-values were accepted whereas the items whose calculated t-value was not significant, were rejected. The results related to mean, SD, and t-value for each item are given in Table 3.8

Table 3.8 Mean, SD and t-value for each Item

<table>
<thead>
<tr>
<th>S. No.</th>
<th>High Thinking Skill of IPC Group (HTSIPCG) Mean</th>
<th>SD</th>
<th>Low Thinking Skill of IPC Group (LTSIPCG) Mean</th>
<th>SD</th>
<th>t-value</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>3.833</td>
<td>.3808</td>
<td>1.667</td>
<td>.561</td>
<td>23.135**</td>
<td>Accepted</td>
</tr>
<tr>
<td>2.</td>
<td>5.437</td>
<td>.4251</td>
<td>1.2500</td>
<td>.7372</td>
<td>44.417**</td>
<td>Accepted</td>
</tr>
<tr>
<td>3.</td>
<td>3.3125</td>
<td>.4121</td>
<td>1.0000</td>
<td>.4423</td>
<td>31.870**</td>
<td>Accepted</td>
</tr>
<tr>
<td>4.</td>
<td>3.312</td>
<td>.2473</td>
<td>3.2292</td>
<td>.3605</td>
<td>1.696</td>
<td>Rejected</td>
</tr>
<tr>
<td>5.</td>
<td>3.333</td>
<td>.408</td>
<td>3.229</td>
<td>.551</td>
<td>1.735</td>
<td>Rejected</td>
</tr>
<tr>
<td>6.</td>
<td>3.395</td>
<td>.3605</td>
<td>3.291</td>
<td>.4149</td>
<td>2.005</td>
<td>Rejected</td>
</tr>
<tr>
<td>7.</td>
<td>3.395</td>
<td>.3605</td>
<td>3.291</td>
<td>.4149</td>
<td>2.005</td>
<td>Rejected</td>
</tr>
<tr>
<td>8.</td>
<td>4.895</td>
<td>.4658</td>
<td>1.2500</td>
<td>.7372</td>
<td>41.601 **</td>
<td>Accepted</td>
</tr>
<tr>
<td>9.</td>
<td>3.833</td>
<td>.3807</td>
<td>1.667</td>
<td>.5614</td>
<td>23.136**</td>
<td>Accepted</td>
</tr>
<tr>
<td>10.</td>
<td>3.791</td>
<td>.4872</td>
<td>1.0208</td>
<td>.4539</td>
<td>46.153**</td>
<td>Accepted</td>
</tr>
<tr>
<td>11.</td>
<td>4.666</td>
<td>.3510</td>
<td>1.562</td>
<td>.6645</td>
<td>39.042**</td>
<td>Accepted</td>
</tr>
<tr>
<td>12.</td>
<td>3.3125</td>
<td>.4619</td>
<td>.5700</td>
<td>.5108</td>
<td>33.888**</td>
<td>Accepted</td>
</tr>
<tr>
<td>13.</td>
<td>3.625</td>
<td>.2658</td>
<td>1.0417</td>
<td>.5299</td>
<td>31.000**</td>
<td>Accepted</td>
</tr>
<tr>
<td>14.</td>
<td>3.354</td>
<td>.375</td>
<td>3.229</td>
<td>.488</td>
<td>2.01</td>
<td>Rejected</td>
</tr>
<tr>
<td>15.</td>
<td>3.3125</td>
<td>.4121</td>
<td>1.0000</td>
<td>.4423</td>
<td>31.870**</td>
<td>Accepted</td>
</tr>
</tbody>
</table>

** Significant at 0.01 level.
Thus it can be seen from the Table 3.8 that except t-values for items 4, 5, 6, 7 and 14 all t-values are significant. Therefore the items having non-significant t-value i.e. item numbers 4, 5, 6, 7 and 14 were rejected and the remaining items were retained. In this way final draft of Thinking Skill of IPC test consisting of ten items, was made.

**Step V : Reliability**

The reliability of the Thinking Skill of IPC Test was determined through test-retest method. The Test-retest reliability refers to the consistency of scores obtained by the same individual when re-examined with the same test on different occasions. For establishing the Test retest reliability, the test was administered to 130 students of class IX. The same test was administered to the same students with a gap of one month. For the test-retest reliability, the correlation coefficient was computed on the basis of the scores of 130 students on two testing. The correlation coefficient was found to be .90. Therefore it can be said that the reliability coefficient was found to be high. Hence the Thinking Skill of IPC test was considered to be reliable.

**Step IV : Validity**

Validity means a tool measures what it is supposed to measure. The content validity refers to the systematic examination of test to find out whether it covers a representative sample of the behaviour to be measured. For establishing the content validity of the Thinking Skill of IPC Test, it was shown to experts from the field of Education, Psychology and Testing. The researcher had discussion with the experts regarding the content of the test. The experts were of the opinion that the items fairly represented the content. Along with the content validity, the researcher also established the face validity of the test. According to Anastasi(1970) face validity of the test means whether it looks valid to the subjects who take it. For establishing the face validity of Thinking Skill of IPC Test, the reactions of the subjects for whom the test was constructed were obtained and the test was found to be valid. Hence the Thinking Skill of IPC Test was having both face as well as content validity. The Thinking Skill of IPC Test is given in Appendix - II.
3.3.3 Intelligence

Intelligence as a concept has been understood in different ways by different psychologists. According to Stern (1914), “Intelligence is the general capacity of an individual consciously to adjust his thinking to new environments. It is the general mental adaptability to new problems and conditions of life.”

According to Bagnon (1937) - “Intelligence is the capacity to learn and adjust to relatively new and changing conditions.”

Intelligence tests both verbal and non-verbal have been developed and standardized by different researchers for different age levels. For measuring Intelligence of the students, Verbal Intelligence Test developed by R. K. Ojha and K. Ray Chowdhary (1971) was used. This is an objective Intelligence test which has 8 parts namely classification, analogies, synonyms, number test, completion test, paragraph test, best reason and simple reasons. Each part has different number of items. The total numbers of items are 112. The maximum score is 112. Forty minutes were given to complete this test. The reliability of this test was established by Split half method and Kudar Richardson Formula. These different parts have reliability 0.87, 0.81, 0.86, 0.71, 0.74, 0.64, 0.58, 0.79 and 0.75 respectively by Split half method while 0.91, 0.89, 0.88, 0.73, 0.88, 0.68, 0.79, 0.81 and 0.83 reliability respectively by Kudar Richardson Formula. The validity of this test was established by calculating correlation between the eight parts of this test.

3.3.4 Self Confidence

According to Good (1973) "Self-confidence refers to faith in one's own ability” which enables the individual to be dependable on himself, to rely upon his own judgment, not to be submissive and to feel himself adequate to do the things, he wants to do. It overcomes all the barriers and develops the ability to tackle even tough situations successfully.
without depending on others and to have a positive self-evaluation. Self Confidence tests have been developed and standardised by different researchers for different age groups. Bhawalkar (1992) developed Self Confidence scale and the test-retest reliability was found to be 0.464 which was significant, but not of a very higher level. The test was developed for the age group of 14 to 16 years. Sharma (1992) conducted a study using Bhawalkar's Self Confidence scale on a sample whose age ranged from 12 to 14 years. In the present study self-confidence of both the groups i.e. experimental and control belonging to class IX section A and B of New Father Angel Higher Secondary School was assessed with the help of Agnihotri's Self-Confidence Inventory (ASCI, 1987). Agnihotri's Self Confidence Inventory (ASCI) comprised of 56 statements. Each statement was followed by two alternatives. The students were required to choose one from the given alternatives which best described their position. The inventory is self-administering in nature. There is no time limit. Ordinarily an individual takes 20 minutes to complete the inventory. The students were requested not to leave any item unattempted. A score of one was awarded for a response indicative of lack of Self-confidence, i.e. for making cross (x) to wrong response to item numbers 2, 7, 23, 31, 40, 41, 43, 44, 45, 53, 54, 55 and for making cross (x) to right response to the rest of the items. Hence, the lower the score, the higher would be the level of Self-confidence and vice-versa.

The split-half reliability of the test was found to be .91 and test-retest reliability was found to be 0.78, which is significant at 0.01 level. Thus, the verbal measure of Self-confidence used in present investigation was considered to be reliable. The inventory was also validated by correlating the scores obtained on this inventory with the scores obtained by the subject on Basavanna's (1975) Self-Confidence Inventory. The validity coefficient obtained is .82, which is significantly beyond .01 level. The self-confidence inventory is given in Appendix - XI.
3.3.5 Personality

The term Personality is derived from the Latin word *Persona* which means mask. According to Allport (1948) - “Personality is a dynamic organization within the individual of those psychophysical systems that determine his unique adjustment to his environment.”

Eysenck (1972) gave three basic dimensions of Personality.

1. Introversion-Extroversion
2. Neuroticism (Emotional instability – Emotional stability)
3. Psychoticism.

In this study researcher had considered Introversion Extroversion Personality of students.

Personality of the students was assessed with the help of Maudsley’s Personality Inventory (MPI), (1972) originally developed by Eysenck and later adapted by Jalota and Kapoor for Indian population in Hindi and Punjabi language. The MPI was designed for assessing neuroticism, stability and introversion extroversion dimensions of the Personality. This inventory can be used for a group or an individual for both adolescents and adults. There was no time limit but the subjects usually took 20 minutes to respond. The inventory consisted of 48 items. Against each item, three choices were given, namely “Yes”, “?” and “NO”. The student had to read the statement and select any one choice. The scoring was done as per the instructions given in the manual. The split-half reliability coefficient for Extroversion-Introversion was 0.42. It had content validity. The MPI is given in Appendix – XIII.

3.3.6 Creativity

Creativity generally resembles divergent thinking. According to Drevdahl (1956) - “Creativity is the capacity of a person to produce compositions, products or ideas which are essentially new or novel and previously unknown to the producer.”

In the present study BaqarMehndi (1973) test of Creativity was used for Creativity assessment. In this test 3 sections were there for different activities. In activity I two
figures are given. Subjects were supposed to draw anything according to their Creativity with these figures. In activity II, 10 different small, incomplete figures were given. In activity III, some triangles and rounds are given. Subjects can draw as many figures from them as they wanted according to their ideas. There is a time limit of 15, 10, and 15 minutes for these activities respectively. Subjects were also required to give a title for each figure. The scoring was for both, the title and the figure. Marks were assigned according to the instructions given in the manual. Low creative and high creative students can be categorized by it.

3.3.7 Tolerance of Ambiguity

According to Good (1959), the word ‘Ambiguity’ means the quality of being subject to variable interpretations, the quality of being easily influenced by subjective factors. Engle (1957) defined tolerance as mutual understanding and harmony among divergent groups; also as a willingness to bear with and appreciate those whose views differ from one’s own views.

The Tolerance of Ambiguity of students was assessed with the help of Tolerance of Ambiguity test developed by Bhavalkar (1992) for the children of 13-15 years age group. The test comprised of 15 items having situations pertaining to day-to-day experiences, each followed by three alternatives. These three alternatives indicated the three levels of Tolerance of Ambiguity. The subjects were supposed to mark only one alternative which they found most suitable for themselves. The maximum score credit is 45 for this test. A score of 1-15 indicates low level of Tolerance of Ambiguity, that of 16-30 indicates moderate Tolerance of Ambiguity level and that of 31-45 indicates the high Tolerance of Ambiguity level. There is no time limit but usually an average time of 30-35 minutes is required for completing the task. The split half reliability coefficient was found to be 0.50. The content validity and face validity of the tool were also established. The test of Tolerance of Ambiguity is given in Appendix – XII.
3.3.8 Study Habits

According to Good (1959): Study Habits are, (i) The tendency of a student to study when the opportunity is given. (ii) The student’s way of studying, whether systematic or unsystematic, efficient or inefficient etc.

For the assessment of Study Habits of students Study Habits Inventory developed by Mukhopadhyaya and Sansanwal (1983) was used. This inventory consisted of 9 different kinds of study behaviour. These were comprehension, concentration, task orientation, sets, interaction, drilling, supports, recording and language. The test contained both positive and negative items. Total number of items was 52. The scoring procedure was 4, 3, 2, 1, and 0 for positive items while 0, 1, 2, 3, 4 for negative items. The reliability of the whole inventory was worked out by using Split Half Method. The reliability coefficient was 0.91. the Study Habit Inventory is given under Appendix – XIV.

3.3.9 Reaction of the Students towards Instructional Material

The Reaction Scale was developed by the investigator for assessing the reactions of students of experimental group towards Instructional Material. Each aspect of Instructional Material was put in the form of a statement to which the students were expected to react in order to express the extent to which it helped them in developing Thinking Skill of IPC. The scale comprised of 20 statements which were to be rated and scored. The various aspects reflected in the statements were IPC skill, thinking power, self-expression, clarity of thought, self-learning, scope of divergence, sequencing of learning material, self-confidence, interest etc. Against each statement a 5 point rating scale was given. The five points were
a. To a very great extent
b. To a great extent
c. To an average extent
d. To a little extent
e. To a very little extent

The students were asked to read each statement carefully. If one strongly agrees with the aspect given in the statement to a very great extent, right mark (√) was to be put under that caption. In case one only agree with statement, right mark (√) was to be put on under the caption ‘To a great extent’ and respectively under other captions according to their choice. Like this, out of the five given alternatives, right mark (√) was to be put on only one alternative for each statement. There was no fixed time for giving the responses, but the students were asked to complete fast and not to spend more time on each statement. The weightage assigned for positive statements was 5, 4, 3, 2, 1 respectively and for negative statements 1, 2, 3, 4, 5 respectively. The scale is given in Appendix - III.

3.4.0 PROCEDURE FOR DATA COLLECTION

For the purpose of data collection first permission from the principal New Father Angel Higher Secondary School, Indore was taken. After that the rapport was established with the students of class IX and they were oriented for the present study. The subjects were made acquainted with the tasks they had to perform and the respective criteria to be followed.

For measuring Thinking Skill of IPC, test developed by the investigator, it was standardized by the researcher. The usual procedure of standardization was followed, which comprised of item selection, item analysis and establishment of reliability and validity. This portion of the present study constituted the First Stage sample, belonging to New Father Angel Higher Secondary School (Section C & D) and Green Field Public School (Section B). For the second stage, the sample belonging to New Father Angel Higher Secondary School (Section A& B) was taken. One section was randomly selected for the treatment. A group of 82 students of two sections namely, section A and B were
selected for experimentation. Out of 82 students 42 students belonged to experimental group i.e. section A and 40 students belonged to control group i.e. section B. Firstly all the students of both the groups were administered Achievement Test developed by the researcher. They were asked to read the instructions given in the exercise and write their responses in the space provided. The time limit for the test was 90 minutes. After Achievement Test, Thinking Skill of IPC test was conducted following all the norms of administration of test. All precautions were followed carefully, so that reliable data could be obtained. After completing the exercise by the students, the response sheets were collected by the investigator. After that, the measurement of co variables namely Creativity, Intelligence, Personality, Tolerance of Ambiguity, Self-Confidence and Study Habits was done by standardized tools before starting the experimentation. After the testing of both the groups the next step was to start the treatment through Instructional Material. To make it clear to the students all the relevant information about Instructional Material was given to the students. On the other hand, same topics were taught to the control group through traditional method. The procedure continued till all the selected topics were completed. Post testing was done by applying the same tool to see the effectiveness of Instructional Material in the development of Thinking Skill of IPC of both the groups i.e. Experimental and Control groups. The Reaction Scale was administered only to the experimental group at the end of the treatment to get the reaction of the students towards the Instructional Material. The scoring of various tools was done as per the scoring key developed by the researcher, but the scoring for standardized tools was done as per the scoring scheme given in the manual.

3.5.0 STATISTICAL TECHNIQUES

Objective wise statistical analysis is given below.

1. To compare the adjusted mean scores of Achievement in Science of the students of experimental and control group by considering Pre- Achievement
in Science as covariate, the data were analyzed with the help of one way ANCOVA.

2. To compare the adjusted mean scores of Thinking Skill of Identifying Pros/Cons of the students of experimental and control group by considering Pre-Thinking Skill of IPC as covariate, the data were analyzed with the help of one way ANCOVA.

3. To study the effect of treatment, Intelligence and their interaction on Achievement in Science of students by considering Pre-Achievement in Science as covariate, the data were analyzed with the help of 2x2 factorial design ANCOVA.

4. To study the effect of treatment, Personality and their interaction on Achievement in Science of students by considering Pre-Achievement in Science as covariate, the data were analyzed with the help of 2x2 factorial design ANCOVA.

5. To study the effect of treatment, Creativity and their interaction on Achievement in Science of students by considering Pre-Achievement in Science as covariate, the data were analyzed with the help of 2x2 factorial design ANCOVA.

6. To study the effect of treatment, Tolerance of Ambiguity and their interaction on Achievement in Science of students by considering Pre-Achievement in Science as covariate, the data were analyzed with the help of 2x3 factorial design ANCOVA.

7. To study the effect of treatment, Study Habits and their interaction on Achievement in Science of students by considering Pre-Achievement in
Science as covariate, the data were analyzed with the help of 2x3 factorial design ANCOVA.

8. To study the effect of treatment, Self-confidence and their interaction on Achievement in Science of students by considering Pre- Achievement in Science as covariate, the data were analyzed with the help of 2x3 factorial design ANCOVA.

9. To study the effect of treatment, Intelligence and their interaction on development of Thinking Skill of Identifying Pros and Cons of students by considering Pre- Thinking Skill of IPC as covariate, the data were analyzed with the help of 2x2 factorial design ANCOVA.

10. To study the effect of treatment, Personality and their interaction on development of Thinking Skill of Identifying Pros and Cons of students by considering Pre- Thinking Skill of IPC as covariate, the data were analyzed with the help of 2x2 factorial design ANCOVA.

11. To study the effect of treatment, Creativity and their interaction on development of Thinking Skill of Identifying Pros and Cons of students by considering Pre- Thinking Skill of IPC as covariate, the data were analyzed with the help of 2x2 factorial design ANCOVA.

12. To study the effect of treatment, Tolerance of Ambiguity and their interaction on development of Thinking Skill of Identifying Pros and Cons of students by considering Pre- Thinking Skill of IPC as covariate, the data were analyzed with the help of 2x3 factorial design ANCOVA.
13. To study the effect of treatment, Study Habits and their interaction on development of Thinking Skill of Identifying Pros and Cons of students by considering Pre- Thinking Skill of IPC as covariate, the data were analyzed with the help of 2x3 factorial design ANCOVA.

14. To study the effect of treatment, Self-confidence and their interaction on development of Thinking Skill of Identifying Pros and Cons of students by considering Pre- Thinking Skill of IPC as covariate, the data were analyzed with the help of 2x3 factorial design ANCOVA.

15. To find out the effectiveness of Instructional Material in terms of reactions of students, for this objective the data were analyzed with the help of Mean and SD.