CHAPTER III

METHODOLOGY

In this chapter the details of sample and tool developments are described. In section 3.1 the methodology (research) adopted in this research work is explained. In section 3.2 the sampling technique that has been adopted in this study is explained. Section 3.3 describes the various activities, which are considered in this study. Section 3.4 describes the tool development procedures. The last section describes the statistical methods used in this study for the analysis of data collected.

3.1 Methodology and Instruments

The main objective of the present study is to find out the presence of creativity component as competency in the curricula of B.E Computer Science and Engineering of Anna University. However, for comparative study, the curricula of non-formal (various non-formal Computer Training Institutes in Tamilnadu) as well as other formal courses in Computer and Information Technology such as M.Sc. (I.T) of University of Madras have been taken into consideration. Various popular subjects pertaining to B.E., (Computer Science & Engineering) of Anna University have been considered as a base for the study. The sample unit contents of B.E., (CSE) subjects of Anna University, is presented in Appendix I

Four popular subjects pertaining to both formal and non-formal education in Computer and Information Technology viz., C++, Java, Web Technology and Visual Basic have been considered for the study. The sample Unit Content of M.Sc., (I.T) subjects of University of Madras, is presented in Appendix II. Several question papers of different academic years pertaining to each of the subjects, were considered for this purpose.
The instruments used in this study are of three types viz., i) Survey through structured questionnaires, ii) Interview schedules and iii) Detailed content analysis on question papers. A sample feedback questionnaire is appended as Appendix III.

3.2 Sampling Technique

The sampling is based on ‘Purposive sampling’ referred in Sharma B.A.V. (1963). The purposive sampling is selected by some arbitrary method, because it is known to be representative of the total required data, or it is known that it will produce well-matched groups.

A total of 260 B.E., (CSE) students, studying in different Engineering Colleges located in different parts of Tamil Nadu has been considered for data collection. In addition 250 samples were surveyed both from formal and from non-formal course students of IT. This sample is accorded for the first instrument. Refer Appendix III for Model Questions.

A total of 25 eminent experts both from software industry as well as Academics have been selected for intervention. This is adapted for the second instrument. A sample benchmark questionnaire, designed for this purpose is presented in Appendix IV. The feedback responses on ‘Creativity’ alone, have been extracted from Dr.T.G.Sambanthan (2000)

25 reference materials and 25-question papers (model question papers as well as examination question papers) were taken into consideration for collecting the data related to the presence of direct and indirect usage of action verbs pertaining to creativity. This is used for the third instrument viz., content analysis. A sample set of Anna University Examination question papers considered for the Content Analysis is presented in Appendix V. A list of ‘creativity’ action verbs, collected from various sources, as referenced in the Literature Survey Chapter (Chapter II) is presented in Appendix VI. This forms a consolidated list of ‘directly used action verbs (Refer Appendix VI).
The researcher himself executed the survey, conducted the interviews and did the content analyses. The collection of data for all instruments was limited to the following criteria:

1. Survey was limited to the state of Tamilnadu.

2. Survey was done in a few districts of Tamilnadu (Purposive Sampling).

3. Several Non-formal Educational institutes of both organized as well as unorganized sectors have been planned for coverage in the study.

4. The user might be either from rural based or urban based, having different educational levels viz., Plus 2 to Master’s degree levels in the Non-formal sector.

5. In the formal sector the survey would be limited to M.Sc. (IT) students and B.E (CSE) students from different colleges of Madras University and Anna University respectively.

6. The study on the presence of creativity verbs in the reference books and question papers of B.E (Computer Science and Engineering) would be restricted to the latest syllabus of Anna University. A list of Textbooks and Reference materials considered for Content Analysis, is presented in Appendix IV

7. The users would be from both male and female candidates.

8. The subjects of M.Sc. (IT) and B.E (CSE) and also Non-formal were restricted to four subjects viz., C++, Java, Web Technology and Visual Basic.

9. The usage of action verbs to find the presence of creativity in the reference books of B.E (Computer Science and Engineering) would be restricted to 15 subjects viz., Interactive Computer Graphics, Object Oriented Programming, Electronic Circuits, Semiconductor Physics & Opto-Electronics,


11. This response / feedback would be subjected to statistical analysis.

Table 3.1 Final Instruments and Sampling used for the Research

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Instruments</th>
<th>Sample</th>
<th>Target Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Intervention Subjects</td>
<td>25</td>
<td>Experts</td>
</tr>
<tr>
<td>2</td>
<td>Subjects (Question Papers)</td>
<td>15</td>
<td>B.E., (CSE)</td>
</tr>
<tr>
<td>3</td>
<td>Syllabus (Subjects)</td>
<td>20</td>
<td>B.E.(CSE)</td>
</tr>
<tr>
<td>4</td>
<td>Subjects (Syllabus &amp; Question Papers)</td>
<td>4</td>
<td>M.Sc., (I.T)</td>
</tr>
<tr>
<td>5</td>
<td>Questionnaires</td>
<td>260</td>
<td>B.E., (CSE)</td>
</tr>
<tr>
<td>6</td>
<td>Questionnaires</td>
<td>250</td>
<td>Non-Formal &amp; M.Sc., (I.T)</td>
</tr>
</tbody>
</table>
3.3 Development of tools

The task of the data collection has been taken up after this research problem has been defined and research design / plan chalked out. It has been decided to take up two types of data, namely primary and secondary for collection. The primary data are those, which are collected afresh for the first time and thus happen to be original in character. The secondary data, on the other hand, are those which have been collected by someone else and already passed through the statistical process. The method of collecting primary and secondary data differ, since primary data are to be originally collected, while in case of secondary data, the nature of data collection work is merely that of compilation.

3.3.1 Collection of primary data

Primary data has, hence, been collected during the course by experimental means. The researcher scrutinized nearly 25 reference materials and 25 question papers to get the data related to the presence of creativity verbs in the reference materials and question papers. It has already been mentioned in 3.2 that the technique adopted was ‘Purposive sampling’. The collection of relevant action verbs on creativity has been explained in Chapter II on ‘Literature Survey’.

We can obtain primary data either through observation method or through direct communication with respondents in one form or another or through personal interviews. This, in other words, means that there are several methods for collecting primary data, particularly in surveys and descriptive research. Important ones are (1) Observation method (2) Interview method (3) through questionnaires (4) through schedules and (5) other methods which includes (a) warranty cards (b) distributor audits (c) pantry cards (d) consumer panels (e) using mechanical devices (f) through projective techniques (g) in-depth interviews and (h) content analysis.
3.3.2 Collection of data through Questionnaires

This method of data collection is quite popular, particularly in case of large data enquiries. This method is generally being adopted by private individual research workers, private and public organizations and even Governments. In this method a questionnaire is sent (usually by post) to the persons concerned with a request to answer the questions and return the questionnaire. The questionnaire consists of a number of questions printed or typed in a definite order on a form or set of forms. The questionnaire is mailed to respondents who are expected to read and understand the question and write down the reply in the space meant for the purpose of questionnaire itself. The respondents have to answer the questions on their own.

3.3.3 Main aspects of Questionnaires

Quite often a questionnaire is considered as the heart of the survey operation. Hence it has been very carefully constructed. It has to be properly setup, so that the survey will serve the purpose. This fact requires us to study the main aspects of a questionnaire viz, the general form, question sequence, and question formulation and contents. It is essential to note the following with regard to these three main aspects of questionnaire.

3.3.4 General form

So far as the general form of questionnaire is concerned, it must, either, be a structured or co-structured questionnaire. Structured questionnaires are those questionnaires in which there are definite, concrete and pre-determined questions available. The questions are presented with exactly the same wording and in the same order to all respondents. The form of a question may either be closed (i.e., of the type ‘yes’ or ‘no’) or open (i.e., inviting free response) but should be started in advance and not constructed while using the questionnaire. Structured questionnaires may also have fixed alternative questions in which responses of the respondents are limited to the stated alternatives. Structured questionnaires are
simple to administer and relatively inexpensive to analyze. The provision of alternative replies, at time, helps to understand the meaning of the questions clearly.

3.3.5 Question Sequence

In order to make the questionnaire more effective and ensure expected quality to the replies received, attention was paid to the question sequence in preparing the questionnaire. A proper sequence of questions, reduces the chances of individual questions being understood considerably. The question–sequence was made clear and smoothly moving, meaning thereby that the relation of one question to another would be readily apparent to the respondent, with questions that are easier to answer, are being placed or kept in the beginning. Difficult questions were relegated towards the end so that even if the respondent decides not to answer such questions, considerable information, would have, already, been obtained. The question sequence was made to go from the general to more specific and it was assured that the answer to a given question would be a function not only of the question itself, but of all previous questions as well. For instance if one question deals with the usage of ‘creativity’ verb in question paper and the next with usage in class room teaching, the answer to the latter question may be couched largely in terms of question paper.

3.3.6 Question formulation and content development

With regard to this aspect of questionnaire, it should be noted that each question must be very clear to avoid any sort of misunderstanding, which can do irreparable harm to the survey. Questions were designed to be impartial, in order not to give a biased picture of the true state of affairs. Questions were also designed (constructed) with a view to their forming a logical part of a well thought out tabulation plan. In general, all questions met the following standards: (a) should be easily understood (b) should be simple i.e., should convey only one idea at a time (c) should be concrete and should conform as much as possible to the respondents’ way of thinking.
3.3.7 Essential Characteristics of a Questionnaire

To be successful, the questionnaire designed was comparatively short and simple i.e., the size of the questionnaire has been kept to minimum. Questions were made to form a logical sequence moving from easy to more difficult questions. Personal and intimate questions were left to the end. Technical terms and vague expressions capable of different interpretations were avoided in questionnaires. Some questions were dichotomous (‘yes’ or ‘no’) type of answers, multiple choice (alternative answers listed) or open-ended. The latter types of questions are often difficult to analysis and hence, were avoided in the questionnaire to the extent possible. Questions that might affect the sentiments of respondents were avoided. Adequate space for answers was provided in the questionnaire to help editing and tabulation. Provisions have been made for indications of uncertainly, “do not know” "no preference" and so on. Finally the physical appearance of the questionnaire was designed, to obtain the cooperation from the recipients and as such, an attractive questionnaire, is a major advantage for seeking cooperation. The quality of the paper, along with its colour, was good so that it might attract the attention of recipients. A sample of the final Questionnaire that was validated and tested, is presented in Appendix III.

This thesis work is based on the following two important methods:

1. Survey Method: The researcher followed ‘Survey Methods’ which aim at designing questionnaires and obtaining feedback responses. The data would aim at using for the study of a formal Master's degree Course in Information Technology viz., M.Sc (IT). This also aims at comparing with that of Non–formal computer courses dealing with similar areas as that of IT. These Non–formal courses are from various educational streams offered by private promoters. The feedback questionnaires used for survey methods, is presented in Appendix III. The sample unit content of M.Sc., (I.T) subjects of University of Madras, used for survey methods, is presented in Appendix II.
2. Interview Schedules: The researcher conducted personal interviews from eminent academicians such as University Vice Chancellors, Directors of Technical Education, Deans and senior faculty from renowned Institutions like IIT and Senior Computer Professionals from software Industry etc., The sample benchmark questionnaire used for intervention, is presented in Appendix IV. This Instrument was used by the researcher, in order to get first-hand information from the interviewees.

The results expected from different end users in both formal as well as Non formal education in IT. Hence the end users are taken for the studies include students of both formal (M.Sc) and Non-formal (several privately run computer institutes in the state of Tamilnadu).

It was planned to apply survey methodology to such subjects of IT, (due to the reason that they are taught both in formal and Non–formal sectors) as C++, Java, Web Technology and Visual Basic.

The research study was, however, restricted to the presence of ‘Creativity’ component of the cognitive domain as explained in the Introduction of this thesis. Hence the questionnaire was designed such that several action verbs pertaining to ‘Creativity’ would be found out. The action verbs were collected from different sources. They were elaborated in the second chapter on ‘Literature Survey’. Refer Appendix VI for a list of ‘Creativity Action verbs’.

The questionnaires were designed for collecting data pertaining to 1) the usage in ‘subject content’ as specified by the designers of the respective curriculum
2) usage in the classrooms by teachers taking theory classes
3) usage in laboratory practical classes and also by teachers dealing with student project works
4) Reference books prescribed by the curriculum and also
5) in question papers.
3.4 Analytical Tools

3.4.1 Content Analysis: The researcher scrutinized the reference materials and previous year question papers of Anna University to collect the data. Research was done on presence of creativity verbs in Question papers and reference materials of B.E (Computer Science & Engineering). The sample unit content of B.E., (CSE) subjects of Anna University, which were used for the 'Content Analysis' is presented in Appendix I. The list of Text books and Reference materials used for the Content Analysis, is presented in Appendix VII. Samples of Anna University Examination question papers are presented in Appendix V. A list of directly used 'creativity action verbs' used for the 'Content Analysis' is presented in Appendix VI.

3.4.2 Interpretation of data:

After the collection of pertinent data through the appropriate tools, instruments and techniques, the organization, analysis and interpretation of data and formulation of conclusions and generalization to get a meaningful picture of the raw data collected, is described. The mass of data collected through the use of various tools, however reliable, valid and adequate it is, but still it is raw. It needs to be systematized and organized i.e., edited, classified and tabulated before it can serve any worthwhile purpose.

Editing implies the checking of gathered data for accuracy, utility and completeness. Classifying refers to the dividing of the information into different categories, classes of heads for use. Tabulating denotes the recording of classified material in accurate mathematical terms eg., making and counting frequency tallies for different items on which information is gathered. Before tabulating, all the raw data were tested on the basis of the purpose for which they are gathered and only the useful and usable data have been tabulated.
3.4.3 Analysis of data

Analysis of data means studying the tabulated material in order to determine inherent facts or interpretations. It involves breaking down existing complex factors into simple parts and putting together in new arrangements for the purpose of interpretation.

Analysis as a process enters into research in one form or the other from the very beginning in the selecting the problem, in the determination of methods and in interpreting and drawing conclusions from the data gathered. A plan has been prepared in advance before the actual collection of data. Because, a preliminary analysis on the skeleton plan should, as the investigation proceeds, develop into a complete final analysis, enlarged and reworked as and when necessary.

An alert flexible and open observation was maintained for processing. No similarities, differences, trends, and outstanding factors should go unnoticed. Larger division of material has been broken down into smaller units and rearranged in new combinations to discover new factors and relationships. Data was studied from as many angles as possible to find out fresh and newer facts. Good, Carter and Scates (1954) suggest four helpful modes to analyze the gathered data.

1. To think in terms of significant tables that data permit.

2. To examine carefully the statement of the problem and the earlier analysis and to study the original records of the data.

3. To get away from the data and to think about the problem in layman's terms or discuss the problem with others.

4. To manipulate the data by making various simple statistical calculations. These helpful points have been taken into consideration while doing the analysis.
3.5 Statistical Methods

In the general process of analysis of research data, statistical methods have contributed to a great extent. Statistical methods have been extensively applied for the analysis. The following are some statistical methods of analysis used in this research.

3.5.1 Common Statistical methods

1. Calculating frequency distribution (usually in percentage) of items under study.

2. Calculating measures of central tendency – mean, median and mode.

3. Calculating measures of dispersion – Standard deviation, Mean deviation, Quartile deviation and Range.


5. Graphical presentation of data – Line graphs, Pie graphs, Bar graphs, Histograms etc.

3.5.2 Formulae for interpretation of results

While interpreting the results secured after performing statistical analysis of complex data, it is essential to test whether the observed values or differences in statistics (Mean, SD, R etc) are all significant, whether they are not caused by any chance due to errors of sampling. If significant, how significant they are. For answering such questions the statistical device used, is that of calculating the probable error of the statistics in question. It takes the following forms:
- Probable error of the Mean
- Probable error of the correlation coefficient
- Probable error of the difference between means or other measures.
- Histograms
- Test of students and analysis of variance.

Suitable statistical formulae have been applied to find out, at what levels of significance, the results can be relied on or in other words, what is the extent upto which the chance factors can play, is observed in results.

3.6 Formulation of conclusions and generalizations

All care and caution in formulating conclusions and arriving at generalizations on the basis of data have been exercised. Like interpretation of results, the formulation of conclusions and generalizations also demands keen observations, wider outlook and application of logical thinking.

3.6.1 Formulating generalizations

1. Before drawing up conclusions and generalizations, it is advisable to summarize the findings of the study and compare them with the hypothesis formulated in the beginning.

2. All conclusions drawn, should be based on the evidence of sound, adequate data. All questionable or incomplete data and that are yet be verified, assumptions should be avoided.

3. Before drawing any conclusions or generalizations, they should be tested for agreement with facts and laws of nature that are already established and for verification purposes.

4. They must be stated in simple and precise terms.

5. They must answer the questions asked in the statement of the problems.
6. They must prove or disprove the hypothesis made in the beginning.

7. They must recognize the limitations of the study.

8. They must be accompanied by suggestions for application or practical use and suggestive problems for further investigation.

With the above limitations and suggestive means, the feedback responses have been analyzed and results along with discussions are presented in the next chapter.

3.7 Benchmark Design

As specified in the objectives of this research work, a benchmark must be arrived at, which would consist of the percentage of different levels of the competencies (Bloom's classification in the cognitive domain) for all the streams. These different levels, therefore, must be considered as the respective competencies for a particular course. This study adopts Interview scheduling with eminent persons from Technical Education and Professionals from software Industry.

In the present work, only 'Creativity' in the cognitive domain is considered for the research. It should be noted that the benchmark would certainly be empirical in nature, as the percentage of competencies are derived from opinions received from eminent and distinguished persons of (Technical) Education and not inferred from any scientific experiment. The study may, thus be considered as social in nature. A mean is computed from the feedback results, (when the standard deviation is less).

The 'Creative ability' as a competency is considered to get the feedback. It should be noted that the quantity of creative ability, which is qualitative in nature, is taken in terms of 'High', 'Medium', 'Fair', and 'Nil' for the computation of benchmark values. The range of values for the purpose of analysis, are assumed as found overleaf.
H (High)    : > 75%
M (Medium)  : > 50% and < 75%
F (Fair)    : > 25% and < 50%
N (Nil)     : < 25%

The creativity (which is creative ability and should not be confused with the ‘creativity’ in the general psychological content) has been included for the entire stream in the questionnaire.

From the statistical analysis done on the feedback responses obtained, the range of values for different streams are presented below:

**Table 3.2   Range of values that are required for different Streams of CSE & IT**

<table>
<thead>
<tr>
<th>Diploma</th>
<th>B.Sc.,</th>
<th>M.Sc.,</th>
<th>B.C.A</th>
<th>M.C.A</th>
<th>B.E.,</th>
<th>M.E.,</th>
<th>B.Tech (IIT)</th>
<th>Non-Formal</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>F</td>
<td>F</td>
<td>M</td>
<td>H</td>
<td>H</td>
<td>F</td>
<td>H</td>
<td>F</td>
</tr>
</tbody>
</table>

It should be noted that the requirement for B.E (CSE) is ‘High’, which is over 75%, as suggested by experts.
3.8 Validity of the tools

A sample set of 10 feedback responses, was collected from both formal and Non-formal computer students. The Non-formal students included both the organized as well as from unorganized sectors. The feedback responses were then presented to eminent academicians belonging to technical education and opinion was obtained in order to validate the results found. It is to be noted that the benchmarks were obtained from Vice chancellors of Universities, Directors of Technical Education, and Senior Professors from IIT Madras, Anna University etc. This benchmark would be compared with the obtained data for the analysis.

With these limitations, the collected data are analyzed and the results are discussed in the next chapter.