CHAPTER NO 111

DESIGN OF THE RESEARCH AND HYPOTHESES
Design of the Research and Hypotheses

Main purpose of this chapter is to develop the design of the research and to formulate hypotheses by integration of the researches discussed in the previous chapter.

This chapter deals with the following points:

3.1. Selection of samples.
3.2. Conceptual framework for the development of instructional material.
3.3. Design of the experiment.

3.1. Selection of Samples:
3.1.1. Bruner and his associates have conducted researches on the attainment of conservation concepts proposed by Piaget in three different areas. These areas are America, Mexico and mid-west Africa. These three groups are related to different degrees of technical growth. In his study Bruner found that cognitive growth of people depends upon the level of the technological growth of the country. Bruner found the differences in the cognitive development which according to him was due to the development of technology in these three countries. He proposed the theory of instrumental conceptualization in order to explain these differences.
The three levels where he conducted the experiment could be arranged on the dimension of technological growth as follows:-

America where technological growth is maximum, Mexico where technological growth is medium and Senegal mid-west Africa where it is the least.

In the same way Soman has selected three levels for his cross-cultural research on teaching and its effect on the attainment of scientific concepts. Along the dimension of technological growth he has selected three groups viz; U. K. where technological diffusion is maximum, Indian urban area where it is medium and Indian rural area where it is the least.

Both these studies are conducted on cross-cultural level. These researches are conducted on macro level where comparison is between the two countries which differ in cultural context. But this work can be done in the same country under same cultural environment. Such cultural comparison could be made by conducting researches at micro level between the different groups under the same culture i.e. intra-cultural comparison. In India on the basis of technological development the
same three levels, as referred to above, are evident.

3.1.2. India is a semi advanced country trying to catch up with the technical advances taken place in the western countries. Along the dimension of technological innovations and their diffusion there are three distinct intra-cultural levels. Knowledge of technology is not spread all over the country. Technological diffusion has not taken place equally in this country. Technological growth is at its maximum in Urban areas, less in rural areas and least in adivasi areas. Only a small part of the Indian population lives in urban areas which are industrialized. Major part lives in rural areas and lives on agriculture. A small segment of the total population lives in Adivasi areas which maintains itself on the collection of jungle products. Both the areas i.e. rural and adivasi are separated from the urban area due to poor channels of communication, hence the three areas differ from each other with respect to the technological growth and diffusion.

It would be interesting to find out the effect of these technological differences on the scholastic achievements of the students in these areas. Let us critically discuss these three areas in this respect.
3.1.3. If we take into account urban areas, we find that these areas are technologically more advanced. People in these areas are familiar with modern technological growth which has played a crucial role in bringing about the progress in western countries. People in urban areas make use of electronic equipments, such as Computer, tape recorder, T.V, radio and V.C.R. etc., for different purposes. Due to industrialization, people have become product-oriented. Hence people in these areas are progressive in view and are trying to adopt new methods in every walk of their lives. This in turn is reflected in school environment which has become congenial in nature. Different technological equipments such as T.V, radio, tape recorder and V.C.R. are easily available in schools. Technical expertise required to manipulate and to make use of these media for education is also available. This encourages the teachers to bring about innovations in education with the help of different media. These new ideas and technological innovations motivate both the teachers and the students to adopt progressive outlook towards education.

3.1.4. There is another end of the pole from this point
of view viz; Adivasi areas. These areas are like solitary islands. They are cut off from the main stream of the society due to poor channels of communications. The life of these people is characterized by same rigid attitudes such as superstition, blind faith and conservation etc. Main amenities of life they draw from jungle products for which they lead a nomadic life. Hence unstable life, due to which they have to face poverty constantly. Their aspirations are limited to the fulfillment of basic needs of the family. Hence they can not think of formal education of their children. Incidental learning which takes place in the family is also very limited and meager.

Channels of communication being very poor, the people are not aware of the developments taking place in the modern world. Hence the parents don’t realise the importance of educating their children. Because of this attitude on the part of the people to run a school in these areas is itself an adventure.

Government is trying to develop Ashram Shalas where first generation learners are taking education at present. There are also some private social agencies which have organised a few centers of learning where
Adivasi children are getting education. The center at Kosbad in Thane district which organises pre-primary, primary and secondary schools is a well known example in this case.

Because of the circumstances as discussed above, these schools are naturally following age-old traditions and teachers resort to traditional teaching methods. Hence the teachers are more conservative in nature and are least motivated to use educational innovations in schools.

3.1.5. With respect to technological growth, rural areas lie between the two extremes. Main occupation of the people is agriculture, so they have stable life. In order to sell their agricultural products they have to keep contact with the people in urban areas. Hence channels of communication between rural areas and urban areas are better developed. Because of such contacts people in rural areas are well aware of technological advancements. They are trying to catch up with the progress that is already taking place in urban areas. They have started using modern equipments. They are bringing innovations in farming and other agricultural activities.
As compared to urban areas people in rural areas are conservative in nature. But they are more progressive than adivasi people. Stable family life provides rich opportunities for the informal education of their children. Children learn family trends by imitating elderly members of the family. Thus traditional knowledge is transferred from one generation to another.

With regard to formal education there are a numbers of full fledged schools catering education to the children population in these areas. Children regularly come to schools except during harvest time when they have to help their parents in farm activities. This creates disturbances in school functioning and hence quality of learning suffers.

Being in contact with the urban areas the teachers are somewhat progressive in attitude towards new educational innovations and are prompt to use them in schools in their daily teachings. Because of social constraints and limited economic sources they cannot utilise this knowledge of technology for the betterment of teaching and at times they have to fall back on old traditional methods of learning where rote learning is predominant.
3.1.6. Thus one can easily find that there are socio-cultural differences in these three layers which are reflected in the functioning of educational institutions in these areas. These differences in turn have their impact on scholastic achievements of the students. As is evident in the table. (Table No. 1 Pg 10) chapter I.

The children in these three areas mentioned above differ in the scholastic achievements. So the problem before the educationist is how to close this gap that exists between the scholastic achievements of the children from different areas.

Could we use modern educational learning theories to bring the students in rural and adivasi areas in the line with those of urban areas with respect to their scholastic achievements?

In this direction the present research intends to study the effect of instructional material based on three different modes, viz; enactive, ikonic and symbolic, as proposed by Bruner in his theory of instrumental conceptualisation, on the attainment of mathematical concept by the students in the adivasi, rural and urban areas of this state.
3.2. Conceptual Frame - work

3.2.1. In this case the lead is given by Bruner and his associates. (1966) Bruner and his associates have conducted cross-cultural researches on the attainment of conservation concept as proposed by Piaget in Mexico and mid-west Africa.

Out of the researches conducted in Africa by Bruner emergence of theory of Instrumental conceptualisation has taken place. This theory holds that what is known is constrained and determined by the characteristics of the organism within, i.e. biological heritage, and by the characteristics of environment from without i.e. cultural heritage. It develops the notion of representation. The organism encodes and stores the experience of the outer world in different ways, through actions, images and through symbols of words. These ways determine also the nature of representation. Thus there are three modes of representation, viz; enactive mode, ikonic mode and symbolic mode. At the beginning child tries to cope with the environment and meets the demand through action i.e. enactive mode. Repeated encounter with environment leads to images i.e. ikonic mode. This in turn gives rise to symbolic mode of representation.
Thus three modes are instruments of concept formation of the outer reality and hence he designates his theory as instrumental conceptualisation.

According to him integration of these modes leads to the better acquisition of knowledge of the outside world. (reality)

Bruner (1966) found out during his research work, "School is a single most crucial variable which makes effect in the direction of cognitive growth". He was mainly interested in cognitive development rather than scholastic achievements.

Soman (1979) has tried to extend his work in cross-cultural context by studying three different groups with respect to achievements in science. He has used interaction of three different modes for the development of instructional material on the Boyle’s law in science which will lead to achievement on part of the students.

In this research work it is intended to go a step further to investigate the effects of intermode comparisons by preparing the programmes in three different modes separately and by evaluating the achievements of the students in mathematics.
Thus the present study intends to investigate the effects of intra-cultural differences on the acquisition of mathematical concept along with the dimension of schooling and technological growth. The three groups under consideration are, urban, rural and adivasi groups represented by the children in Maharashtra state.

3.2.2. This study intends to do intra-cultural comparison. Comparison could be effectively done if the criteria of the equivalence of the different groups must be taken into consideration.

Berry and Dason (1974) have given the criteria of equivalence for valid cross-cultural comparison. The same criteria are used in this intra-cultural comparison.

The criteria are:
2. Functional equivalence.
3. Metric equivalence.
3.2.2.1. Conceptual Equivalence :-

The first criterion demands that there should be conceptual equivalence with respect to content while comparing different cultural groups. In this research work content is concerned with mathematical concept. Content in this study is two topics in mathematics which will be taught to all the groups and then their achievements will be evaluated. Thus it satisfies this criterion.

3.2.2.2. Functional Equivalence :-

Functional equivalence demands functional similarity in the schools from which the samples are taken. In this work the institutions, in which research will be carried out, are all run by the management which follow the rules and regulations set by the Maharashtra State. It means the schools are functionally same in every respect i.e. content, routine, evaluation procedure and methods etc..

Thus it ensures the criterion of functional equivalence with respect to the group.
3.2.2.3. Metric Equivalence:

This equivalence demands that the tools of measurement and methods of analysis of data are same in all the groups.

Here in this study the same pre-test and post test will be administered to all the groups to measure achievements. Results will be treated with the same statistical tools of evaluation. Hence the achievements could be compared and their attainments in mathematical concept could be compared by using ANOVA technique and Scheffe test will be used for inter-group comparison.

Thus criterion of metric equivalence holds good in this respect.
3.3. Design of the Research study:

This study intends to investigate an intra-cultural differences with regard to the attainment of mathematical concepts by the children of age 11 to 12 from Maharashtra state.

The main objectives of the study already are discussed in as follows:

Two questions arise here:

1. Are there real differences between the achievements of the different cultural groups?
2. Could we eliminate the effects of cultural differences on the achievement of mathematical concepts?

The problem boils down to the fact whether we could close the gap by using the programmes prepared in the form of three different modes.

3.3.1. OBJECTIVES OF THE STUDY

To find out the answer to the above questions, the objectives of the study are as follows:

1. To prepare the instructional material in order to train the students through different modes.
2. To prepare the test to evaluate the achievements of the students.
3. To compare the scores of three different groups with the view to do inter-cultural comparison of three different groups in terms of their attainment in the mathematical concepts.

In the light of the above questions and objectives on the basis of the researches, discussed in the section 3.1 and 3.2 of this chapter, an attempt is made to formulate a strategy for intra-cultural research. The basic strategy used here is to study the nature of intra-cultural influences on the acquisition of the mathematical concepts by three intra-cultural groups viz; urban, rural and adivasi is to prepare learning material based on Bruner’s modes of representation and to administer it to the different groups i.e. urban, rural and adivasi and to compare the differences in their achievements as revealed by their performances on post-test.

In order to find out the answers to the above question. It was thought desirable to use the experimental method as the main method of the present research study.
3.3.2. VARIABLES INVOLVED IN THE STUDY

3.3.2.1. Independent Variables:

There are two main independent variables in this study. They are three instructional methods (treatments) and three cultural groups.

3.3.2.1.1. Three Methods:

The three instructional methods or treatments aimed at developing mathematical concepts among the children of three different groups under consideration as follows:

1. Method I(E) - It includes the programmes based on Enactive mode. This programme demands activity on part of the students during teaching - learning environment.

2. Method II(I) - It includes the programmes which uses Bruner's Ikonic mode of representation. Here images are given more emphasis while preparing the programmes.

3. Method III(S) - It includes the programmes which is based on Symbolic mode as proposed by Bruner. Language plays main role in this case.
3.3.2.1.2. Three Cultural groups:

These methods of instructions are administered to three different types of groups representing three different levels of technological growth and schooling as discussed earlier in this chapter. They are designated as Group A, Group R and Group U respectively as follows:

1. Group A - It includes a group of sixty students between the ages 11 to 12 from adivasi schools from Kosbad, district Thane in Maharashtra State.

2. Group R - It includes a group of sixty students between the age groups of 11 to 12 from the rural schools near Saswad, district Pune in Maharashtra State.

3. Group U - It includes a group of sixty students between the age group of 11 to 12 from the urban schools of Pune in Maharashtra state.

The students are chosen on the basis of pre-test and are randomly assigned to each group ARU. Each group was divided again into three groups. These groups were assigned to each method randomly. Thus there are in all nine groups each of 20 students, number of the students in the study being 180.
3.3.2.2. Dependent Variable:

The dependent variable is the acquisition of the subject matter of (1) sums of the interior angles of a polygon and (2) Expansion of algebraic identities $(X+Y)^2$, $(X-Y)^2$, $(X^2 - Y^2)$ by the students as measured in terms of scores on the post test. The tests are composed of questions of three types. These three types of questions are based on the three modes of representation as proposed by Bruner viz; enactive mode, ikonic mode and symbolic mode. Instructional material is also based on these modes. Main effects are measured in terms of the raw scores on the post-test.

M. R. Matrix as proposed by Sawada is used for preparing different items in the post test as discussed in chapter IV (page 126).

3.3.3. Statement of Hypotheses:

On the basis of the discussion in section 3.2. Two generalizations are made with respect to the two question raised above

1) With respect to methods – It is hypothesized that the effects of method E is more than method I which in turn is more effective than method S.

2) With respect to groups – It is hypothesized
that the groups will differ with respect to the achievements as follows -
Achievements of groups U will be of group A will be less and of group R will be between.

3.3.3.1. HYPOTHESES:

(A) Hypotheses with respect to the effects of different methods on immediate post-test.

Main Hypotheses - (Total Effect)
1. There would be no significant difference between the effects of the three methods "E", "I" and "S" respectively within the achievements of the same cultural groups and between the achievements of different cultural groups on the immediate post test as a whole.

Subsidiary Hypotheses -
1. There would no significant differences between the effects of three methods in relation to the achievements of Adivasi groups.
2. There would no significant differences between the effects of three methods in relation to the achievements of Rural groups.
3. There would no significant differences between the effects of three methods in relation to the achievements of Urban groups.
4. There would no significant differences between the effects of enactive method on the achievements of different cultural groups.

5. There would no significant differences between the effects of ikonic method on the achievements of different cultural groups.

6. There would no significant differences between the effects of symbolic method on the achievements of different cultural groups.

3.3.3.2. Hypotheses with respect to the achievements on different mode questions:

Main Hypotheses - (Total Effect)

1. There would no significant difference within the same cultural groups and between the different cultural groups (i.e. Adivasi, Rural and urban) with respect to their achievements on questions as related to three different modes (i.e. Enactive, Ikonic and Symbolic) included in the immediate post test.
Subsidiary Hypotheses:

1. There would be no significant differences within the achievements of Adivasi groups on Enactive, Ikonic and Symbolic mode questions in the immediate post test.
2. There would be no significant differences within the achievements of Rural groups on Enactive, Ikonic and Symbolic mode questions in the immediate post test.
3. There would be no significant differences within the achievements of Urban groups on Enactive, Ikonic and Symbolic mode questions in the immediate post test.
4. There would be no significant differences between the achievements of Adivasi, Rural and Urban groups on Enactive mode questions in the immediate post test.
5. There would be no significant differences between the achievements of Adivasi, Rural and Urban groups on Ikonic mode questions in the immediate post test.
6. There would be no significant differences between the achievements of Adivasi, Rural and Urban groups on Symbolic mode questions in the immediate post test.
3.3.3.3. Hypotheses with respect of effects of methods on delayed post test:

Hypotheses: (Total Effect):

Main Hypotheses:

1. There would be no significant differences between the effect of the three methods 'E', 'I' and 'S' respectively within the achievements of the same cultural group and between the achievements of different cultural groups on the delayed post-test as a whole.

Subsidiary Hypotheses:

1. There would be no significant differences between the effects of the three methods in relation to the achievements of Adivasi group on delayed post-test.

2. There would be no significant differences between the effects of the three methods in relation to the achievements of Rural group on delayed post-test.

3. There would be no significant differences between the effect of the three methods in relation to the achievements of Rural group on delayed post-test.

4. There would be no significant differences between the effects of enactive method on the achievements of different cultural groups on delayed post-test.
5. There would be no significant differences between the effects of ikonic method on the achievements of different cultural groups on delayed post-test.

6. There would be no significant difference between the effects of symbolic method on the achievements of different cultural groups on delayed post-test.

3.3.4. EXPERIMENTAL DESIGN

In view of the previous discussion as related to intro-cultural comparison it seems that the questions generated might be properly answered by means of experimental study involving three types of cultural groups, with carefully designed instructional methods used over a short period of time, followed by a multi- variated analysis of outcomes.

The randomised factorial design 3X3 is found to be suitable for the present research work because of the following reasons as given by Hayes (1964).

1. It has got the strength of the basic experimental design, the most important of which is the randomisation feature and the consequent ability to assume the pre-experimental approximate equality of the groups in all possible independent variables.
2. History and maturation are controlled because very little time elapses between manipulation of the independent variables i.e. instructional methods and the observation and measurement of dependent variable i.e. achievement on the immediate post-test and retention of delayed post-test.

3. It permits the need of controlling all intervening variables such as intelligence, maturity, aptitude, interest and other personality variables. All these variables can be controlled by randomised sampling.

A key to generalisation because it enables to control the error variance created by different intervening variables discussed above and ensures the internal and external validity of the experiment.
3.3.4.1. The factorial design set up in this research can be expressed diagrammatically as follows:

**Schematic representation of the experimental design**

<table>
<thead>
<tr>
<th>Programmes</th>
<th>Programmes</th>
<th>Programmes</th>
<th>Programmes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groups</td>
<td>E</td>
<td>I</td>
<td>S</td>
</tr>
<tr>
<td>Adivasi Group</td>
<td>N = 20</td>
<td>N = 20</td>
<td>N = 20</td>
</tr>
<tr>
<td>Rural Group</td>
<td>N = 20</td>
<td>N = 20</td>
<td>N = 20</td>
</tr>
<tr>
<td>Urban Group</td>
<td>N = 20</td>
<td>N = 20</td>
<td>N = 20</td>
</tr>
</tbody>
</table>

Dependent variable in terms of score on post-test.
3.3.4.2. Degrees of freedom and two-way analysis of variance:

This design of research involves two-way analysis of variance i.e. between methods and between groups of students and possible interaction between the two. The degree of freedom can be positioned as follows:

<table>
<thead>
<tr>
<th>Source</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main effect</td>
<td></td>
</tr>
<tr>
<td>1. Between Methods</td>
<td>2</td>
</tr>
<tr>
<td>2. Between Groups</td>
<td>2</td>
</tr>
<tr>
<td>3. Interaction</td>
<td>4</td>
</tr>
<tr>
<td>4. Errors</td>
<td>171</td>
</tr>
<tr>
<td>Total</td>
<td>179</td>
</tr>
</tbody>
</table>

3.3.5. Statistical Procedures:

The techniques of one-way analysis and two-way analysis of variance are used to analyse the effects i.e. scores on post-test. The fixed effects are tested against the error term i.e. within the group variance and the significance between means of different groups are judged by following the usual criteria at four different levels of significance .001, .01, .05, and .10 ANOVA technique. For comparison between the means of different groups Scheffe test will be used.
Different tools were considered in order to do multiple comparison between the groups. Different tests like Tukey, Scheffe, etc. were considered. Scheffe test because of its rigorosity was considered. Hence in some cases even lower level of significance like .10 at some place Scheffe test will be used.

3.3.6. Control Of error variance (Internal Validity)

3.3.6.1. This point is related to the internal validity of the experiment. Here the problem is how to control variance due to extraneous variables. These are not directly related to the problem but are definitely affecting independent variables and the dependent variables indirectly i.e. performance of the students on the test. There are individual variables such as sex, age, intelligence, attitude, interest, previous knowledge of the student and other personality variables. There are social variables like caste, religion and social class.

3.3.6.2. The variable of previous knowledge is controlled by selecting students on the basis of their performance on the pre-test. Age variable is controlled by selecting the students between the age of 11 to 12
years. All the other variables like sex, intelligence and the like are taken care of by randomization. The randomized group design is used. The students are selected randomly on the basis of results on the pre-test and are randomly assigned to different groups which are in turn randomly assigned the to different methods.

Thus the internal validity of the experimental design is ensured.

3.3.6.3. In all research studies teacher variable is an important crucial variable. It is to be controlled properly, more so in case of intra-cultural and cross-cultural studies. Soman has eliminated this variable by administering programme learning i.e. self learning on skinnerion line. Taking into consideration the nature of the design of this study, it was thought desirable to control this variable by administering instructional programme in standardized fixed procedure by the same teacher only.

Thus the internal validity of the experimental design is ensured.
3.3.7. External Validity:

External validity is nothing but generalizability of the experiment. That means to generalize the use of the design from one environment to other. Thus the problem here is to ensure to what extent are the results of this experiment generalizable to other culture, other than those which are included in this study.

This factor of external validity is important in case of any research study, specially in case of intra-cultural studies. It is important because in addition to the experimental variables involved in the study, many other intra-cultural variables pertaining to the cultures (environmental, technological growth region etc.) creep in the study and may affect the independent variables and affect the results. To control these variables randomized group design will be used.

Randomization will be done at 3 different levels. 1) While selecting total numbers of subjects 2) While selecting individuals for different groups and 3) While assigning groups to different teaching methods.
Thus every attempt is made to secure internal and external validity of the total experiment with a view to increase the effectiveness of the research programme.

Thus internal and external variables are controlled by using randomized group design.