CHAPTER- III: PROBLEM AND PROCEDURE

3.0 INTRODUCTION

In the foregoing chapter, an attempt was made to review the literature available on different models for course development and self-instructional material and its components, characteristics. All the models and procedures were aimed at improving the quality in development of course material.

As this is an experimental study, an attempt is made in this chapter to explain the problem and the procedure of the study. In other words, the whole design of the study is explained in this chapter.

3.1 THE PROBLEM

As observed in the rationale of the study, in the first chapter, that there is a need for the inclusion of foundation course in mathematics at undergraduate level and as found from the review of the literature, the second chapter, that no study was conducted so far in the development of foundation course in mathematics for distance learners, the statement of the problem is given below.

3.1.1 Statement of the Problem

DEVELOPMENT OF SELF INSTRUCTIONAL MATERIAL FOR FOUNDATION COURSE IN MATHEMATICS FOR DISTANCE LEARNERS OF OPEN UNIVERSITY

3.1.2 Operational Definitions

To ensure clarity of expression and consistency throughout the study, the following terms were defined.

3.1.2.1 Development

In the present study the investigator used the following procedure for the development of the course.

Selection of the topic  Course Content and Task Analysis  Target Population  Entry Level Behaviour  Terminal Behaviour  Criterion based performance test on each block (Formative Evaluation)  Comprehensive test (Summative Evaluation)  Editing  Revision  Final form the course Material

3.1.2.2 Self-instructional Material

In this study, the self-instructional material is the course material developed by the investigator in self-instructional format similar to the format being used in BRAOU.
3.1.2.3 Foundation Course in Mathematics

In the present study the investigator developed and used foundation course in mathematics to develop the mathematical skills among the students in the first year of undergraduate programme of Dr. B.R. Ambedkar Open University as fifth additional subject along with the existing four foundation courses.

3.1.2.4 Distance Learner

In the present study the distance learner is the student of first year undergraduate programme who enrolled in undergraduate programme offered by Dr. B.R. Ambedkar Open University either through direct admission (Students with Intermediate qualification with and without mathematics) or admission through Eligible Test (Students with educational qualifications ranging from below SSC, SSC and upto Intermediate failed).

3.1.2.5 Formal Stream Students

In the present study, the investigator used formal stream students for the students enrolled into the Open University by satisfying formal entry requirements i.e. with Intermediate/equivalent qualifications and studying the first year Under Graduate Programme at Dr. B. R. Ambedkar Open University.

3.1.2.6 Non-Formal Stream Students

In the present study, the investigator used non-formal stream students referring to the students enrolled through the Eligibility Test conducted by Dr. B. R. Ambedkar Open University and producing proof of being 18 years of age or above and studying the first year Under Graduate Programme at Dr. B. R. Ambedkar Open University.

3.1.2.7 Open University

In the present study, the investigator used Open University as the Dr. B. R. Ambedkar Open University.

3.2 OBJECTIVES OF THE STUDY

The main purpose of the study is to develop the Self-instructional course material in mathematics for distance learners of Open University and to find out its effectiveness. Hence, the objectives of the study are given below:

1. To design and develop the self-instructional course material for the foundation course in mathematics for distance learners of Open University.
2. To study the effectiveness in terms of the performance of the distance learners on criterion tests.
3. To prepare final form of the course material based on the results of the validation.
4. To find out the effectiveness of the final form of the self-instructional course material of the Foundation Course in Mathematics in terms of the performance of the distance learners of Open University on the achievement test in mathematics.

3.3 HYPOTHESES

3.3.1 Hypothesis for first and second objectives

With reference to the first and second objectives it is expected that the developed course material is at the level of the students

3.3.2 Hypotheses for the third and the fourth objectives

The following Null hypotheses are formulated on the third and the fourth objectives

1. There is no significant difference between the mean scores of comprehensive test and that of combined criterion tests.
2. There is no significant difference between pre-test and post-test mean scores of students, from both Non-formal stream (below SSC, SSC, Intermediate failed) and formal stream (Intermediate qualified but without Mathematics) taught through Self-Instructional Course Material.
3. There is no significant difference between mean scores of Experimental Group [Students of Non-formal stream (below SSC, SSC, Inter failed), and students of Formal Stream (Intermediate qualified without Mathematics)] and Reference Group [Students of formal stream having Intermediate qualification with Mathematics] in the achievement test in Mathematics.

3.4 RESEARCH DESIGN

Research design for the present study would be discussed under two sections. First section deals with the development of course material, and the second section deals with the Experiment to find out the effectiveness of developed course material.

SECTION – I

3.5 DEVELOPMENT OF COURSE MATERIAL

After reviewing the course design models in open Distance Education at national and international scenario, the investigator adopted the course development procedure followed by IGNOU and BRAOU, because the present course was developed for the first year undergraduate students of BRAOU. The present study is similar to the Instructional Development Learning System (IDLS) and the personalized training
model. The course content is presented in linear and semi programmed text style. The investigator had worked in the Dr.B.R.Ambedkar Open University and acted as course coordinator and having experience in writing course material for distance learners. In developing and validation of the present course material, the investigator also kept in mind the other models, characteristics, components, suggestions which have been practicing in the various Open Distance institutions.

The Dr. B. R. Ambedkar Open University and the Indira Gandhi National Open University is following the same procedure for the course development. The present study designing of foundation course in mathematics for distance learners of an Open University was also followed the same procedure for the development of the course.

Since the research is mainly involved with the teachers working in Open Universities or Counselors working in study centers of Dr.B.R.Ambedkar Open University, it was thought that a study of their opinions would give an idea of the designing foundation course in mathematics. Hence, a pilot study was conducted as a preliminary to the construction of the Opinionnaire. The opinions of the teachers regarding the nature and scope of the syllabus to be included for the foundation course in mathematics for benefiting the non-formal stream and as well as formal stream students. This study was carried out by the Opinionnaire. The same would be appearing in the Appendix ‘A’. Each respondent was asked to give a list of topics to be included for designing foundation course in mathematics. The nature and scope of foundation course in mathematics was collected from the teachers of high schools, Intermediate level, university level and the faculty of mathematics department of mathematics of Dr. B.R. Ambedkar Open University.

The developed course consists of 5 Blocks, in each block 4 units, and each unit have sections and further sections have sub sections. The complete course would have 20 units, and in its final form is given Volume II of the thesis.

3.5.1 Outline of the Course

Good instructional design is the core of any quality open distance learning material. It is a systematic process of planning, developing, organizing and evaluating such material (Melton 1997).

Foundation Course in Mathematics would be an additional 5th course, at first year UG Programme of Dr. BRAOU, was identified for development of course material
under the present investigation. The investigator and guiding teacher both were expertise in the development of the course material.

The first task of the course was to develop a *broad outline of the course*. The broad outline of a course includes the following elements identifying the target group, the broad aims of the course, how the course will be structured and the teaching strategies to be adopted.

**a) Target Group**

**b) Aims and Objectives**

**a) Target Group**

All the Under Graduate students at foundation course (1st year of UG Programme) of Dr.B.R.Ambedkar Open University.

**b) Aims and Objectives**

Once the needs were analyzed the next step was to identify in broad terms the aims and objectives of the course. These would show the learners what they might get out of the materials. Also they help the author to decide what to include in the content.

After broad aims have been identified, these need to be broken down into increasingly specific ones. A hierarchical form of analysis was used to achieve this. This involved the breaking down of each broad aim in a sequence stages into increasingly specific aims and objectives as illustrated in hierarchical flow diagram (Figure 3.1). This form of analysis identified in broad terms, the contents of the course and how it could be structured.

*Figure 3.1: Hierarchical analysis of overall aims and objectives*

<table>
<thead>
<tr>
<th>On completion of course the students should be able to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve the quality of life through appreciation and the Understanding of the role of mathematics in daily life, their applications in science and Technology.</td>
</tr>
</tbody>
</table>

- Know and demonstrate understanding of the Quantity
- Know and demonstrate understanding of the Space.
- Know and demonstrate understanding of the Structure.
- Know and demonstrate understanding of the Change.
3.5.2 Model of the course

Of the various models available the model selected by investigator for the present study was illustrated in figure 3.2 (IGNOU Model).

In Figure 3.2 the course is presented in five blocks, each block making up of four units. Further, the unit can be divided into sections and sub sections. The present course has a unit of 4,500 to 8,000 words or 25 to 35 typed (1.5 space) pages (A4 size paper) approximately. This amounts to about 25-35 printed pages.

Keeping in view the skills, attention span and study habits of the learners, the content load should be appropriate and manageable. A unit is a pedagogical unit that can be completed by a learner within a reasonable period of time, say for example, 5-6 hours, i.e., at the most three sittings. Pedagogically, the best unit is the one that can be completed in one sitting. But, then, there are constraints of thematic continuity, attention span, economy, bulk of print materials etc. Which force us to opt for a unit of a larger size, however, it should not be too large to defeat the very purpose for which it is prepared.

![Course Diagram](image)

*Figure3.2: Hierarchical arrangement of components in a course*

The hierarchical analysis of the aims and objectives of the course was used to identify the blocks (Figure 3.3) of instructions which were to be developed and the order in which the blocks can be sequenced.
On completion of the course students be able to

Improve the quality of life through appreciation and the Understanding of the role mathematics in daily life, their applications in Science and Technology.

Know and demonstrate understanding of the Quantity (BLOCK I)

Know and demonstrate understanding of the Space (BLOCK II)

Know and demonstrate understanding of the Geometry and Trigonometry (BLOCK III)

Know and demonstrate understanding of the Calculus (BLOCK IV)

Know and demonstrate understanding of the Statistics and Probability (Analysis) (BLOCK V)

Figure 3.3: Hierarchical analysis of aims and objectives leading towards blocks of instruction of the course

In the “Introduction to the Course” the learners will come to know what they are going to learn, why they have to learn and they are going to do. It is also useful to refer to an ‘advance organizer’. This provides an overview of the textual material the relevance and importance of the topics that are discussed and their objectives, how the course has been structured, the pre-requisites for the course, features that have been used to enable easy learning; the types of assessment that would be used to monitor their progress. Careful attention was paid to stimulate students’ interest in the topics and motivate them.

Thus development process adopted by the investigator had gone through eight distinct stages in a sequence. These stages were:

3.6 DEVELOPMENT OF COURSE CONTENT

1. Selection of the Topic
2. Course content and Task analysis
3. Target population
4. Entry Level Behaviour-Pre test
5. Terminal Behaviour- Post test
6. Criterion tests
7. Format and Style
8. Writing content

3.6.1 Selection of the topic

There are certain topics and subjects which are very difficult to programme, it is not always possible that everything that can be taught can be programmed.

Lysaught and Williams proposed some criteria for selection of the topic as follows:

a) Researcher’s own field
b) Ease of the treatment
c) Length
d) Depressed level of learning
e) Logical order of the material
f) Special student need

The investigator tried to fulfill all the above said criteria for selection of the topic.

a) Researcher’s own field

The investigator is M.Sc. in Mathematics. The investigator worked as academic consultant and acted as course coordinator for open distance learners of Dr. B. R. Ambedkar Open University.

b) Ease of treatment

In developing a self-instructional material, the content would start with as simple as fundamental approach as possible. If the subject matter contains both simple and complex sub units, it is desirable to choose one of the easiest at first and proceed with more difficult ones.

The text took proper care of the above said procedure and develop the self-instructional material the investigator had simplified the matter and one idea was presented as in one concept.

c) Length

While developing a unit, the length of the material should be taken into consideration. It can be broken down to sections and subsections. The short units are desirable in developing self-instructional material. The difficult points would be presented with moderate length.
d) **Depressed level of learning**

For a number of teachers, one factor that has strongly affected the choice of units to be presented in the depressed level of learning shown many of the students who had been taught by current methods of instruction.

The content paid attention in the selection process of those units in his field of knowledge which were difficult to the student without ignoring the criteria of ease and length. The investigator prepared sequence designed to meet the specific hard nuts in the topics. It was done successfully while developing the self-instructional material.

e) **Logical order of material**

In this study the units were from mathematics, so the logical order of material is maintained in the development of concepts. But, there were some jumps from one topic to another topic according to the nature of the study.

f) **Special students need**

Mathematics is considered as a difficult subject, so keeping in mind special need of the students and difficult concepts, the instructional material were developed.

Thus, the investigator has tried to fulfill all the above mentioned criteria for the selection of the topics.

### 3.6.2 Course content and Task analysis

The developed text covers the content of the course foundation course in mathematics for distance learners of an Open University, which is prescribed by as a foundation course for an Open University student. During the instruction, periodical assessment of the students is done by the investigator providing instructions. Students’ learning in the classroom is evaluated as the basis of their performance in the periodical tests in the form of criterion tests and the final comprehensive test.

### 3.6.3 Target Population

Knowing about the intended learners i.e., the target group is required to provide effective open and distance learning materials. As this was an additional 5th course, at first year UG Programme of Dr. BRAOU. The developed course is specifically prepared for utilizing it as self-instructional material in the course “Foundation Course in Mathematics for distance Learners of Dr. B.R. Ambedkar Open University”. Generally the strength of Under Graduate students at foundation course (1st year of UG Programme) ranges from 59,000 -75,000. The Dr.B.R.Ambedkar Open University has adopted a dual approach for admission into undergraduate programme. Firstly, the
direct admission for those who have formal entry qualification (i.e., Intermediate or its equivalent) are eligible to join and secondly, those who do not have such qualifications and have completed 18 years of age but will have to pass the entrance test, called “ELIGIBILITY TEST (ET)” conducted by the university, to be eligible to join into undergraduate programme. The students can be classified into two group’s formal stream and non-formal stream (who constitutes about 75 percent of the total strength).

### 3.6.4 Entry Level Behaviour – Pre -Test

Before giving new learning material to the students, it is absolutely necessary for the teachers to know the level of the previous learning of the students. Fry asserting the importance of previous learning says, “Previous knowledge influences learning, even though the previous knowledge is only vaguely related in the new knowledge being acquired. Entering behaviour is being line from which the terminal behaviour shaped. Entering behaviour shows the initial position of the students. Dececco described the entering behaviour as the present status of the students’ knowledge and skill in reference to a future status the teacher wants him to attain. So that it is easy to measure pre requisite behavior through the pre-test.

In this investigation, the achievement test of the first year UG students for the first was considered as the pre-test. The performance showed by the students was the pre-requisite behaviour.

### 3.6.5 Terminal Behaviour - Post-Test

Considering the proficiency an Under Graduate student acquire through the course for carrying out use of mathematics in the daily life and in concentration to the different content areas included in the course. Terminal objectives were specified in behaviour terms suitably under different units of the course. The lists of terminal behaviors’ for the 20 units of the course have been presented immediately flow-charts, after scope of the course under the heading objectives of the course.

### 3.6.6 Criterion tests

Suitable test items have been developed to cover all the terminal behaviour for the course content. These items are set into five criterion tests which correspond to the five blocks of the course content. These criterion tests have been given in Appendices. However, a brief description of the item types included in these tests is presented here. About 90 percent of the items in each test are of the objective type. Even the essay type items require the students to write only in short answers. Further, for such questions, the
length of the required answers and the number of points to be included in the answers are clearly specified in order to make them as objectively scorable as possible.

Examples:

1. Give three reasons as to why students are afraid of learning in mathematics? (Specify each reason in 2-3 lines only)

2. The objective type questions include wide range of items in order to cover the different objectives specified. These items are listed below:
   A. Multiple Choice item
   B. Completion item
   C. True or False item
   D. Matching item
   E. Recognition item
   F. Direct questions requiring ‘Yes’ or ‘No’

3. Interpretive exercise

   These items require the student to interpret a situation presented and express his answer in a word or two

In addition to the five criterion tests a comprehensive test covering all units of the course prepared. This test also includes all the items described above and covers a representative sample of the objectives set for the complete course.

3.6.7 Format and Style

Suitability of presentation format has to be considered in view of the style of semi programming adopted. The present course content has been written in the linear style, although it is not a linear programme of the traditional Skinnerian type such as the one written by Holland and Skinner (1961). Anyhow, the programme style is basically linear only as all the students have to proceed through the same sequence of concepts. The style of course content bears certain similarities with the one followed Popham and Baker (1970).

A question may arise as to why a linear style has been preferred for branching style of programming. However, linear style has been adopted in the present study because of certain specific reasons. An advantage that is as claimed in favour of branching style is that is more adaptive in its structure for individual differences among the students regarding content mastery. Obliviously, a course written in the linear style does not provide for the above in its structure. However, it may be noted that in the
present case, as has already been pointed out, practically no entering behaviour is presumed on the part of the course content. This rules out, therefore, the possibility of any fundamental difference among the students in respect of the content prerequisites for using the course content. Secondly, it is generally assumed that branching style accommodates individual difference in learning ability of students by including remedial concepts. But, it should be noted that when a uniform entering behaviour in respect of content mastery is assumed, the purpose of remedial concepts boils down to providing explanations as to why a particular answer chosen by a student is incorrect, and leading him to the correct path. This remedial purpose can, perhaps, be achieved in a more economical way by making some departures in the set patterns of concept construction and organization of the linear style. In present course this has been accomplished by suitable explanatory material in between the concepts or as part of succeeding concepts. Illustration of how this has been accomplished is presented in the forth coming sections entitled ’extra reading material’.

Several types of formats have been adopted in presenting the concepts and correct answers in a course content. In the present case, the entire course has been divided in to five blocks. Generally, each block presented one unified theme. The purpose of dividing the course into blocks was a learner may feel a greater sense of achievement each time he completes a block. Further the blocks have been divided into four units each. A unit is a self-contained portion of a block covering one or more interwoven learning concepts. Further, each unit was broken into sections and sub sections for the clarity of the presentation of concepts, information, illustrations etc. Each unit is, thus, an individual lesson and fits into the block it belongs to. It contains orientation for learners, introduction to the content, explanation of the topics covered and exercises to help them learn the material. The investigator taken care of all the units of a block presented is logically and also thematically linked with each other. The length of a unit is also an important feature to be taken into consideration. The present course has a unit of 4,500 to 8,000 words or 25 to 35 typed (1.5 space) pages (A4 size paper) approximately. Keeping in view the skills, attention span and study habits of the learners, the content load would be appropriate and manageable. A unit is a pedagogical unit that could be completed by a learner within a reasonable period of time, say for example, 5-6 hours, i.e., at the most three sittings. Pedagogically, the best unit is the one that can be completed in one sitting. But then, there are constraints of thematic continuity, attention span, economy, etc. which forced to opt for a unit of a
larger size, However, it would not be too large to defeat the very purpose for which it was prepared.

The present course material presented in such a way that a learner can learn from the material independently as it carries out all the functions of a teacher, such as, Self-explanatory, Self-contained, Self-directed, Self-motivating, Self-evaluating, Self-learning, Learning Activeness, Extra Reading Material, Response mode, Evaluation and Revision.

3.6.8 Writing of content

After receiving the nature and scope of the course the content was developed after reviewing the existing models have been practicing in the Open Distance Learning Institutions.

As the first step in developing the outline course content were analyzed in detail. Based on this analysis it was decided to deal with the contents of the course under the four heads. However, after further analysis the first part on introduction of the foundation course in mathematics for distance learners. Thus, for the presentation to the students, the course was finally divided into five blocks. Further, the each block divide into four units and each unit divided into sections and sub section and so on. Finally, the course consists of five blocks and twenty units.

BLOCK I: Number System
BLOCK II: Algebra
BLOCK III: Geometry & Trigonometry
BLOCK IV: Calculus
BLOCK V: Statistics & Probability

Proper sequence for the presentation of the contents was decided on the basis of a flow chart prepared to discover the independency of the different concepts to be covered and the demands they make on the sequencing of content material. Flow chart I to VI presents a total picture of the contents of the complete course. Flow chart II presents the analysis and contents of include Block I. Flow chart III presents the analysis and contents of include Block II and so on.

Based on the detailed task analysis made, specific outline of the topics to be covered under each unit were prepared, specifying the different content points in exactly the same sequence in which they ought to appear in the course content. Those content outlines of the course have been given blow:
Content outlines of the course “Foundation Course in Mathematics for distance Learners of Open University”

**BLOCK I: Number and Quantity**
- UNIT 1: Understanding of the Number System
- UNIT 2: Playing with Numbers
- UNIT 3: Profit and loss, discount
- UNIT 4: Time and Distance

**BLOCK II: Algebra**
- UNIT 5: Sets, Relations and Functions
- UNIT 6: Expressions and Equations
- UNIT 7: Equations and Inequalities
- UNIT 8: Polynomials

**BLOCK III: Geometry and Trigonometry**
- UNIT 9: Geometry
- UNIT 10: Vector geometry
- UNIT 11: Mensuration
- UNIT 12: Trigonometry

**BLOCK IV: Calculus**
- UNIT 13: Limits
- UNIT 14: Continuity
- UNIT 15: Differential Calculus
- UNIT 16: Integral Calculus

**BLOCK V: Statistics and Probability**
- UNIT 17: Data, Presentation of data
- UNIT 18: Measures of Central tendency, Dispersion
- UNIT 19: Permutations & Combinations
- UNIT 20: Probability
3.6.9 Flow charts of the complete course

Figure 3.4: Flow Chart 1: Structure of Complete Course
Figure 3.5: Flow Chart II: Complete Course Content of Block I
Figure 3.6: Flow Chart III: Complete Course Content for Block II
Figure 3.7: Flow Chart IV: Complete Course Content for Block III
Figure 3.8: Flow Chart V: Complete Course Content for Block IV
Figure 3.9: Flow Chart VI: Complete Course Content for Block V
3.6.10 Objectives of the Course

**BLOCK I: Number and Quantity**

*On completion of the block students are able to:*

- develop the numbers concept and place value
- understanding the Number System
- defining the numeracy
- use knowledge and understanding about numbers, calculation strategies and data-handling techniques to solve problems and make decisions in many different contexts
- develop the concept of multiples and factors
- how to identify factors and multiples
- divisibility by different numbers
- how to find Highest Common Factor
- how to find Lowest Common Divisor
- develop your conceptual, clarity on fraction
- differentiate different types of fraction
- apply the concept of fraction in solving day to day problems
- understand the profit, loss and discount
- proof the formulae for simple interest and compound interest
- solve the problems related to principle amount, loan, interest, repayment etc.
- understand the concept of inflation
- develops the concept of ratio and proportion by comparing two quantities
- develop the concept of percent
- find the formulae for speed, time and distance
- calculate the speed, time and distance
- draw distance – time graphs

**BLOCK II: Algebra**

*On completion of the block students are able to:*

- define a set and represent the same in different forms
- define different types of sets such as, finite and infinite sets, empty set, singleton set, equivalent sets, equal sets, sub sets and cite examples thereof
- define and cite examples of universal set, complement of a set and difference between two sets
define union and intersection of two sets
represent union and intersection of two sets, universal sets, complement of a set, difference between two sets by Venn Diagram
solve real life problems using Venn Diagram
define Cartesian product of two sets
define relation, function and cite examples thereof; find domain and range of a function
define and cite examples of different types of functions (one-one, many-one, onto, into and bijection)
determine whether a function is one-one, many-one, onto or into
draw the graph of functions
define and cite examples of odd and even functions
determine whether a function is odd or even or neither
define and cite examples of functions like \(|x|\), \([x]\) the greatest integer function, polynomial functions, logarithmic and exponential functions
define composition of two functions
define the inverse of a function; and state the conditions for the inverse to exist.
derive an algebraic expression
get knowledge about the terms like constant, variable etc.
understand the terms of algebraic expressions such as minimal, binomial, trinomials, polynomial etc.
understand the terms of coefficients such as numerical coefficient, literal coefficient etc.
find the value for algebraic expressions
substituting the values for variables
solve the linear equations
recognize simple linear equations
solve simple linear equations
check that solutions are correct by substitution
define monomial, binomial, polynomial
get knowledge on coefficients, degree and leading terms
do addition, subtraction and multiplication of polynomials
factorization by reminder theorem
recognize the difference between a sequence and a series
recognize an arithmetic progression
find the $n^{\text{th}}$ term of an arithmetic progression
find the sum of an arithmetic series
recognize a geometric progression
find the $n^{\text{th}}$ term of a geometric progression
find the sum of a geometric series
find the sum to infinity of a geometric series with common ratio $|r| < 1$.

**BLOCK III: Geometry and Trigonometry**

*On completion of the block students are able to:*

- know about shapes and their properties
- know basic concepts in geometry
- differentiate between collinear and coplanar
- how to do measure of angles
- use of symbols in geometry
- understand the 2D& 3D shapes
- know the concept of triangles and their properties
- find out the formulas for different shapes
- find out the area of the regular and irregular shapes
- know the concept of circle
- find out the area of the circle
- develop the concept of geometric objects such as line segments, arrows etc.
- do the operations of addition, subtraction and multiplication by scalar
- algebraic representations such as two or three dimensional rectangular Cartesian coordinates.
- do operations on vectors such as dot product and cross product
- proof the Euclidean geometry theorems by vector methods
- understand the standard measurement units
- understand the metric system of measurements (SI Units)
- get knowledge about US standard units
- do conversion of units
- develop the concepts like time, days, week, leap year, AD, BC etc.
- develop the concept of trigonometric ratios of an acute angle of a right angled triangle
proof and applications of identities
problems on heights and distances
define trigonometric functions with the help of unit circle
measuring angles in radians and in degrees and conversion from one measure to another
proofs and simple applications of sine and cosine formulae

**BLOCK IV: Calculus**

*On completion of the block students are able to:*

- define limit
- differentiate between differential calculus and integral calculus
- develop the concept of definite and indefinite
- find out limits infinity
- evaluating limits
- define continuous function
- understand the rate of change
- applications of derivatives such as increasing/decreasing functions
- get an idea about intermediate value function
- know the minima and maxima function
- know about the derivatives and integrals
- rules of derivatives and integration

**BLOCK V: Statistics and Probability**

*On completion of the block students are able to:*

- develop the concept of data
- define types of data
- know about the ways of collection of data
- display the data by using graphs
- write the frequency distribution and relative frequency
- develop the concept center or central value
- calculate the mean, median and mode
- construction of frequency tables
- calculate the range
- calculate the standard deviation and variance
- distribution of data in graphically (NPC)
know the properties of normal probability curve
compare the two variables
develop the concept order and selection
differentiate permutations and combinations
formulate the formula’s for permutations with and without repetitions
formulate the formula’s for combinations with and without repetitions
solve the problems on permutations and combinations
develop the concept probability
know the basic counting principle
understand the terms in probability like events, mutually exclusive events etc.
solve the simple probability problems
probability and its complement
solve problems on conditional probability
find the hidden data
solve the problems by using tree diagrams
solve the problems for mutually exclusive events

3.6.11 Validation of the course

Evaluation of developed learning material for establishing the effectiveness has been considered an integral part of the process of developing such material. Strategies of evaluation adopted in evaluating programmes can be distinguished as internal and external (Harley 1972). Internal evaluation procedure include study of criterion test scores, analysis of errors on the course content and criterion test items etc. Internal evaluation through such procedures is carried out as a part of the developmental and field testing of the developed material. The main purpose of internal evaluation is to revise the course content and sequence and on the basis of empirical results with a view to improve the effectiveness of the developed learning material. Thus, internal evaluation procedure provide answer to the questions how well does the content teach, what it purports to teach, details of internal evaluation made with regard to the course content developed under the present study have already been discussed in the previous chapter.

External evaluation of developed learning material essentially refers to the validation of the course against an external criterion. The external criterion generally set would be in terms of learning effected by the course some other method of instruction.
Thus external evaluation of a course involves experimental comparision of learning
efected by presentation of some instruction material through content, and the learning
effect by the presentation of the same material through one or more other methods of
instruction.

3.6.12 Validation

The following is a detailed account of validating the course content of self-
instructional material developed under the present study.

3.6.13 Try-out

The edited course was of tried out on a group of first year under graduate
students of Dr. B. R. Ambedkar Open University. These students were chosen randomly
from the students admitted into the first year undergraduate programme during the year
2010-2011. The treatment was done from 8th to 25th March 2011. The treatment was
conducted in the form of contact-cum-counseling. To try-out the course the investigator
collected students’ addresses from the computer center of BRAOU and requested them
to attend the contact-cum-counselling programme at community hall (Near
Investigator’s residing colony). This try-out would help the investigator for validating
the course. Appropriate modifications would be made in the course content and
sequence of content.

3.6.14 Final form of the course content

Item wise error analysis of students’ performance on criterion tests will be
carried out. Appropriate modifications would be made in the course content and content
sequence based on the error analysis data.

A complete description of the final form of the course would be after item wise
error analysis. The complete course in its final form is given in Volume II of the thesis.

Title: Foundation Course in Mathematics for Distance Learners of an Open
University.

Target Population: First year under graduate students of Dr. B.R. Ambedkar
Open University.

Content: The course content covers the basic mathematics skills and daily life
use of mathematics and connecting to pursue the higher level mathematics in the future
career. The present course is for under graduate students of Dr. B.R. Ambedkar Open
University. The course divided into five blocks. Further the each blocks divided into
four units. The total course consists of five blocks and twenty units.
SECTION – II

3.7 EXPERIMENT

The One-Group-Pretest-Posttest Design was followed for the experiment to find out the effectiveness of the developed Foundation Course in Mathematics for the first year undergraduate programme of BRAOU.

The One-Group-Pretest-Posttest Design was used which involves three steps; (1) Administration of a pretest measuring the dependent variable (Performance of students on achievement test in mathematics); (2) Implementation of the experimental treatment (Independent Variable i.e. the instruction through developed course material); and (3) Administration of a posttest (The Achievement test) that measures the dependent variable again. The effects of the experimental treatment are determined by comparing pretest and posttest scores.

The Experimental group consists of both students of Non-formal stream (below SSC, SSC, Intermediate failed) and students of formal stream (Intermediate qualification but without Mathematics).

Besides the Experimental Group, a Reference Group was used as a basis of reference in order to compare and evaluate the performance of experimental group of students. The purpose of comparison was to determine whether the new foundation course in mathematics would improve the mathematical skills of the distance learners on par with the students having intermediate qualification with mathematics. As discussed in the rationale of study that for determining the quality and credibility of distance education system. It is generally compared with that of conventional system. For quality and credibility it is important not only the inputs such as course material but also the output, that the performance of the students, and hence the performance of intermediate passed students provides the benchmark needed for comparison with reference to the group of students who occupy the academic level to which the national and state level bodies such as AICTE and APSCHE mentioned that to become eligible MBA/MCA programmes one should have mathematics at +2 level.

3.8 VARIABLES OF THE STUDY

A variable is any measure characteristic or attribute that differs from different subjects. These variables can be classified as quantitative and qualitative or they can be independent and dependent or continuous and discrete.

For this study, the investigator has chosen independent and dependent variables.
3.8.1 Independent Variable

A developed self-instructional material in mathematics at foundation level of first year undergraduate programme of Dr. B.R.Ambedkar Open University.

3.8.2 Dependent Variable

Performance of the students on criterion tests block wise and in achievement test in mathematics.

3.9 SAMPLE

3.9.1 Population of the Study

The first year under graduate students of Dr. B.R. Ambedkar Open University from non-formal and formal streams constitute the population of the study.

3.9.2 Sample and Sampling Technique

As the course material was developed in English medium the sample of students of English medium was chosen from the population from twin cities (Hyderabad & Secunderbad) at First Level. At the Second Level, all the English medium students of first year undergraduate programme were divided into two groups on the basis of educational qualifications. One Group consists of the students with educational qualifications (1) below SSC (2) SSC (3) Intermediate failed and (4) Intermediate without mathematics, while the Second Group consists of the students having intermediate qualification with mathematics.

Keeping in view the availability of English medium students, both from non-formal and formal streams, the students belonging to the study centres in twin cities were selected at the Third Level.

For Experimental Group, a sample of 50 students was selected by using Systematic Random Sampling technique from the First Group which consists of the students with educational qualifications (1) below SSC (2) SSC (3) Intermediate failed and (4) Intermediate without mathematics.

For Reference Group, a sample of 50 students by using Systematic Random Sampling technique from the Second Group which consists of the students having intermediate qualification with mathematics.
### Table 3.1: Table showing the Sample Distribution

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental Group</td>
<td>50</td>
<td>50.0</td>
</tr>
<tr>
<td>Reference Group</td>
<td>50</td>
<td>50.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>100</td>
<td>100.0</td>
</tr>
</tbody>
</table>

### Table 3.2: Table showing the Sample Distribution; Educational qualification-wise

<table>
<thead>
<tr>
<th>Educational Qualification</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below SSC (Non-formal)</td>
<td>23</td>
<td>23.0</td>
</tr>
<tr>
<td>SSC (Non-formal)</td>
<td>8</td>
<td>8.0</td>
</tr>
<tr>
<td>Intermediate failed (Non-formal)</td>
<td>8</td>
<td>8.0</td>
</tr>
<tr>
<td>Intermediate without Mathematics (Formal)</td>
<td>11</td>
<td>11.0</td>
</tr>
<tr>
<td>Intermediate with Mathematics (Formal)</td>
<td>50</td>
<td>50.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>

### 3.10 RESEARCH TOOLS

#### 3.10.1 Opinionnaire

Opinionnaire was used with mathematics teachers at various levels starting from high school to college level to collect the areas in mathematics to design foundation course for distance learners of Open University.

#### 3.10.2 Achievement test

Achievement Test in Mathematics for entry level behaviour (pre-test)

#### 3.10.3 Criterion Tests

Criterion test for five blocks for terminal behaviour (post-test)

#### 3.10.4 Comprehensive Test

A comprehensive test could be used to measure its effectiveness of the developed instructional material (post-test)

### 3.11 RELIABILITY AND VALIDITY OF THE TEST

#### 3.11.1 Reliability of the Test

The reliability of the test refers to the dependability of the scores, their relative freedom from error. Reliability is popularly defined as the consistency of an individual in performing a test. When we are planning to do an experiment with small sample and
we expect only a small mean score difference between the two groups on a particular variable, we will need to use a test that yield highly reliable scores.

In this study the investigator used the effectiveness of the course content is compared combined criterion test scores for the particular two groups which were compared in respect to their mean comprehensive test scores and the mean combined criterion tests. The reliability of the achievement test was tested by test-retest method and the obtained value was 0.8.

3.11.2 Validity of the Test

In any experimental design, the test which is used to find out the effect, the test must be a good one. The tests should measure what it supposes to be measured (validity) with consistency (reliability) using an accurate scoring system (objectivity).

A more comprehensive view of validity is that it encompasses two components, relevance and reliability. Reliability and objectivity are therefore subsumed under validity. The most common type of validity is content, criterion-related and construct.

In this study the investigator utmost care was taken for content validity such as language, typo graphical errors and style, length, sequence, structure etc. Item wise error analysis was carried out by student performance on criterion tests. It revealed that Course Content has the internal validity.

3.12 ADMINISTRATION OF EXPERIMENT

The experiment was conducted of 36 hours in 24 days contact-cum-counselling programme during the year 2011-12 for its effectiveness. In 24 days contact-cum-counselling programme, every day at least one and half hour, a total of 36 hours during the 15th March to 5th April 2012. The investigator collected the students’ addresses from the computer center of Dr. BRAOU and requested them to attend the contact-cum-counselling programme at community hall (Near Investigator’s residing colony). Fifty students, Experimental Group, were selected for treatment from different educational backgrounds such as students of non-formal stream which consist of below SSC, SSC, Intermediate failed, and students of formal stream having Intermediate qualification without Mathematics. Fifty students who have the educational qualification of Intermediate with Mathematics (formal stream) are selected as Reference Group. The Experimental Group was given orientation regarding the instructional material developed for the course viz Foundation Corse in Mathematics for Distance Learners of an Open University. The course material has five blocks, prepared to cover the twenty
units of the course. These blocks have been given in volume II of the thesis. At the
beginning of each block, the objectives of the unit were specified in terms of questions a
student would be able to answer after completing the particular unit. The complete
course material was given to the students, after all the blocks was discussed in the
contact-cum-counselling programme. Although, the content to be delivered through the
lectures was planned before hand and put in the course; the course of the lectures was
made flexible enough to provide for interaction. At the end of each block the criterion
test for that block which was the same as the one given the experimental group was
administered. Five criterion tests would be appearing in the Appendix T, V, X, Z and
AB. Feed back session were organised to discus the performance of the student and
these tests immediately after each test.

The course content given to the experimental group was developed based on a
common task analysis of the course content. As stated earlier the experiment was
conducted for the full length of the course carried out in 36 instructional hours. At the
end of the course a comprehensive test [Appendix-AD, The Achievement Test for entry
level behaviour was repeated (Appendix -C)] based on all units was organized for the
both groups. You could observe both the tests for entry level behaviour and terminal
behaviour are the same i.e. the Appendix ‘C’ is repeated as Appendix ‘AD’ to measure
the terminal behaviour after treatment. All the twenty units covered in Comprehensive
Test.

3.13 COLLECTION OF DATA

Before conducting experiment, the investigator conducted pre-tests i.e. an
achievement test. After completion of experiment, the researcher again conducted the
achievement test as post-test. The score of the students in the pre-test and post-test
formed the vital data for the analysis. In addition to that, the scores of the five criterion
tests, combined criterion test, comprehensive test were also furnished in it.

3.14 STATISTICAL TECHNIQUES USED

The purpose of the study was to develop the self-instructional material and to see
its effectiveness on first year students of formal and non-formal stream of
Dr. B.R. Ambedkar Open University. To find out if there was any significant difference
between experimental and reference group, after collecting of pre-test and post-test
scores, the mean and standard deviation of the data were calculated. “t” test was used to
find out significant difference. Data was analyzed by using SPSS package.
3.15 LIMITATIONS OF THE STUDY

The study has the following limitations.

1. The study is limited to Dr.B.R.Ambedkar Open University.
2. The present study was limited to the print material of the course. The study did not deal with the multimedia.
3. The course was developed in English Medium only.

3.16 CONCLUSION

The problem and procedure of the research has been discussed in this chapter. The problem, statement of the problem, operational definitions, objectives of the study, hypotheses, research design have been discussed in this chapter. Under Research Design, the Course Material Development procedure and the Experimental Design to study the effectiveness of the developed course material on the performance of the distance earners are discussed.

The results of the tests have been analyzed and conclusions were drawn on the basis of data. By this analysis, the hypotheses were tested. The details of analysis and interpretation of the data were presented in the succeeding chapter.