CHAPTER- IV: ANALYSIS AND INTERPRETATION

4.0 INTRODUCTION

This chapter consists of 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 the developed Foundation Course in Mathematics. The present chapter deals with arrangement of the data and statistical treatment for the selected variables. Checking of the conformity and deviation of the hypothesis already mentioned in the chapter III. Realization of the objectives already discussed in the chapter III.

SECTION – I

The procedure of the development of the course material was already discussed in the chapter III. In this section the development of the course material, format of the course, validation of the course, and justification of the course was discussed.

4.1 DEVELOPMENT OF COURSE MATERIAL

The investigator used the following procedure for the development of the course.

The researcher followed the following procedure and format for developing the course material for Foundation Course in Mathematics for distance learners of Open University.

The following procedure is used in the IGNOU and BRAOU to develop the course material. Since the present developed course material was prepared for the students of BRAOU, this section clarifies the how the developed course material gives justification by comparing the existing course development procedure in BRAOU and IGNOU.

4.1.1 Development of Instructional Material

The investigator selected the Dr. B.R. Ambedkar Open University, because distance education is a complementary system of conventional education, and it is not an alternate or substitute. Generally, Correspondence Education and Open Distance Education depend on the print based materials.

The course is developed for the first year undergraduate programme of Open University. In the present study the investigator limited the course to the print material of the course and did not deals with any other media. The course content is presented in linear and semi programmed text style.
The investigator used in developing the self-instructional materials is:

i) Structural content  
ii) Objectives  
iii) Introduction  
v) Summary

It helped the investigator to develop the first draft of course material in the beginning of writing a unit lesson. To conceive a unit in relation to the course and the programme to which it belongs. Every unit has given a clear and explicit title which tells students what the unit is about. The investigator kept in mind that unit titles gave an idea about the content of the unit.

Further the structure of a unit is a detailed itemization of the learning tasks broken into steps/sections and sub-sections. Content titles were arranged in a logical sequence. The investigator also used the psychological principles in writing the content as follows:

- From simple to complex  
- From known to unknown  
- From concrete to abstract  
- From particular to general  
- From actual to representative

After arranging contents, the investigator has allotted a serial number to every step/section and subsection. The investigator allotted serial number 2 to the unit. The steps/sections could be numbered in a sequence using one point e.g. 2.1, 2.2, 2.3 . . . . . . . . . . . . . . . . . . . Similarly a subsection may be represented using two points e.g. under section 2.1, subsections could be 2.2.1, 2.2.2, 2.2.3 . . . . . . Each number allotted conveys a meaning in terms of a unit, a step/section, and subsection. For example in 2.2.2, 2 stand for the unit, the second 2 stands for the first step/section, and the last 2 for the subsection of the second step/section.
4.1.2 Unit Outline

The investigator used the following format for unit outline, the same format used the remaining units of the entire course.

Unit 1 Understanding Numbers and Number System

1.1 Introduction
1.2 Numbers Concept
   1.2.1 Place Value
1.3 Learning about the Number System
   1.3.1 Number operations and Notation
   1.3.2 Relations between Operations
1.4 Methods of Calculation
   1.4.1 Information and Data
   1.4.2 Probability – Predicting
1.5 Using and Applying Knowledge and Skills
   1.5.1 Using Skills in ‘Real-Life’ Situations
   1.5.2 Ways of Approaching Problem-Solving
1.6 The Essentials of Numeracy
   1.6.1 Numeracy
   1.6.2 Definition of Numeracy
   1.6.3 Numeracy Vs. Maths
   1.6.4 Numeracy – For Everyone, For Life
1.7 Number System
1.8 Complex Numbers
   1.8.1 Conjugates
1.9 Let us Sum Up
1.10 Unit end Exercise
1.11 Answers to Check Your Progress
1.12 Suggested Readings
4.1.3 Unit Structure (Model)

The investigator used the following format for unit structure, the same format used the remaining units of the entire course.

<table>
<thead>
<tr>
<th>Structure</th>
<th>Page Nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Introduction</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 Numbers Concept</td>
<td>1</td>
</tr>
<tr>
<td>1.3 Learning About the Number System</td>
<td>2</td>
</tr>
<tr>
<td>1.4 Methods of Calculation</td>
<td>4</td>
</tr>
<tr>
<td>1.5 Using and Applying Knowledge and Skills</td>
<td>6</td>
</tr>
<tr>
<td>1.6 The Essentials of Numeracy</td>
<td>7</td>
</tr>
<tr>
<td>1.7 Number System</td>
<td>10</td>
</tr>
<tr>
<td>1.8 Complex Numbers</td>
<td>14</td>
</tr>
<tr>
<td>1.9 Let us Sum Up</td>
<td>20</td>
</tr>
<tr>
<td>1.10 Unit end Exercise</td>
<td>20</td>
</tr>
<tr>
<td>1.11 Answers to Check Your Progress</td>
<td>21</td>
</tr>
<tr>
<td>1.12 Suggested Readings</td>
<td>21</td>
</tr>
</tbody>
</table>

1.1 INTRODUCTION

Objectives

After reading this unit, you should be able to:

- Develops the numbers concept and place value
- Understanding the Number System

Continued upto Let us Sum Up, Unit end Exercise, Answers to Check your Progress and unit end with Suggested Readings

1.9 LET US SUM UP

1.10 UNIT END EXERCISE

1.11 ANSWERS TO CHECK YOUR PROGRESS

1.12 SUGGESTED READINGS
4.1.4 Justification of the Course Material format

Course Title: Foundation Course in Mathematics

Course Description: The course is designed to first year undergraduates of Dr. B.R. Ambedkar Open University. It is useful to develop mathematical skills in day to day daily life. It also helps the students to pursue higher education in management and computer courses etc.

Themes: The investigator identified the following themes for the present course.
1. Knowledge and Understanding of the Quantity
2. Knowledge and Understanding of the Space
3. Knowledge and Understanding of the Structure
4. Knowledge and Understanding of the Change

Self-Instructional Material

The investigator used the following format in writing the unit and the same format used all the remaining units of the entire course

Components of Unit

UNIT CONSIST OF
- Thematic division
- Information quantum

BEGINNING
- Structure
- Introduction
- Objectives
- Study Guide

STRUCTURE
- Sequencing content
- Easy reading
- Easy comprehension
- Easy retention of memory
- Divisioning
INTRODUCTION

- Linking topics (thematic)
- Linking units (blocks/courses /structural)
- Study guide

4.1.5 Introduction of the Unit

The investigator kept in mind in writing the introduction of the unit, which explains the content being discussed in the particular unit, relates the unit with previous units and also with the existing knowledge of the students. The introduction of each unit has written a brief to provide adequate help to the students in starting their study. In the introduction the investigator also tried to welcome and motivate the students by giving them the impression that what they are going to study in the unit is easy and manageable.

4.1.6 Components of introduction for a Unit

The investigator followed the three components of an introduction of the unit and the same procedure used for all the remaining units of the entire course.

a) 'Structural' component: In an introduction, the investigator has given information about the previous content i.e. what is gone before. Thus, the investigator established a link between what a learner has already learned and what he is going to study in the unit at hand.

b) 'Thematic' component: The investigator tried to attract the students' interest and focus their attention on the content given in the unit. Besides, it could build a basis for and promise friendly and purposeful communication with learners. It is done best by talking informally about the items in the structure i.e. theme of the unit, what content have planned to include in this unit etc. This is an overview describing the main concepts to be discussed in a particular unit.

c) 'Guidance' component: The investigator had provided study guidance to the students to explain the study requirements such as time, special activities, back/cross references, equipment, books etc. It could inform the learner about all that he needs to get the best out of the unit.

4.1.7 Behavioural objectives

The investigator had written behavioural objectives for each and every unit of the course. The purpose of writing instructional objective is aiming at measuring the behavioural changes on the part of the learner. It was stated in behavioural terms using
a measurable or observable “action word” on the set condition or situation and at the desirable standards.

4.1.8 Curriculum objectives in behavioural terms

In the process of development of self-instructional materials the investigator set the first task is to analyze the syllabus was undertaken and identify the capabilities which are intended to be imparted to learners, discussion the subject matter given in the syllabus with other content specialists and describe the intended capabilities in behavioural terms. These capabilities are those which the instruction would equip the students with, after they complete the course/programme.

Target Group: This programme is designed to first year under graduates of Dr. B. R. Ambedkar Open University.

Programme Aims: The aim of the programme is to enable the students to develop the mathematical skills and mathematics usage in their daily life.

Course: The programme consists of five blocks, further each block divide into four units. The programme has total twenty units.

4.1.9 Educational goals and behavioural objectives

The investigator used the following words such as know, understands, learns, appreciates, enjoy, believe, etc. These words are open to many interpretations in writing behavioural objectives. They are analyzed and transformed into specific behavioural objectives which are specific statements and which may use the following kinds of words list, state, identify, differentiate, solve, construct, compare contrast, justify etc.

4.1.10 Development and Validation of 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’.

After receiving the nature and scope of the Foundation Course in Mathematics, the above discussed format was used in developing the course material.
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

After completion of writing the course material, the entire course material which consists of blocks was given away to the students after they completed the each block. At the end of the each block the correspondence criterion test was administered. Performance these criterion tests constituted the twenty units of the of the course content were covered in one academic year.

To validate the developed course, the investigator collected 35 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). It was made clear these beforehand that for the foundation course in mathematics, they should read only the developed learning material given to them but not any other text. Before, giving the course content, the students were oriented about the nature of learning material and procedure of using it. Students were to study the material during the contact-cum-counselling programme allotted for the particular course the course content was presented to the students block wise, the entire course material which consists of blocks was given away to the students after they completed the each block. The criterion tests for block wise try-out i.e. five criterion tests data was obtained by using the Appendices (Appendix E, G, I, K and M).

Difficulties encountered by the students regarding the language, content sequence like were noted. Errors committed by the students on the course content were analyzed. Error analysis was also done for each item of the criterion tests. The average scores obtained by the students on different criterion tests have been presented in table 4.1.

Table 4.1: Mean scores on criterion tests

<table>
<thead>
<tr>
<th>Block No.</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean percentage score</td>
<td>21.69</td>
<td>22.37</td>
<td>14.20</td>
<td>8.77</td>
<td>17.26</td>
</tr>
</tbody>
</table>

Based on the analysis of errors on course units and criterion test items, and also considering the difficulties reported by the students, the course content were revised.
Revision was effected regarding the language, the content sequence, structure of the certain units, and other related aspects. Wherever found necessary content were split into smaller one and also additional content were introduced. The course content after revision was made ready for being used in the phase of evaluation namely, the validation experiment which would be described in the following chapter.

4.1.11 Final form of the course

Item wise error analysis of students’ performance on criterion tests was carried out. The item wise error analysis for block wise (Criterion-wise) data was obtained by using Appendices (Appendix O, P, Q, R, and S). Appropriate modifications were made in the course content, and content sequence based on the error analysis data. It was observed that there was much scope revision in the blocks III, IV & V of the course content. It might be noted that the results of block wise comparison of the course content also revealed that the course effectiveness had decreased towards the last three blocks. The units 15 & 16 in block IV completely revised, basic concepts established to understand the differential calculus and integral calculus. More content were added to the last three blocks, particularly to the unit 11, 12, 18 & 20. As a result of the revision the total length of the course considerably increased. A final form of the course was given treatment for the selected sample from the population to find out the effectiveness of the course content. The succeeding section discuss about the effectiveness of the course content.

The final form of the course as follows:

**BLOCK I: Number and Quantity**

UNIT 1: Understanding of the Number and Number System  
UNIT 2: Playing with Numbers  
UNIT 3: Profit, loss, and discount  
UNIT 4: Speed, 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

The course content contains five criterion tests corresponding to five blocks.

Style: Linear
Language: English
Length: the units are numbered separately for each block. Number of pages in the different blocks is:
Block I: 100, Block II: 126, Block III: 164, Block IV: 76, Block V: 103

The course is covered along with uses of foundation course in first year under graduate programme of Dr. B.R. Ambedkar Open University.

SECTION – II

In this section the administration of experiment to find out the effectiveness of the course content was discussed.

4.2 EXPERIMENT

To study the effectiveness of the course content, the experiment was done on the selected sample as discussed in chapter 3.

4.2.1 Results

Having the above mentioned group of sample, the data was tabulated to calculate the mean, standard deviation on each block for the different groups separately. To know entry level behaviour, the achievement test scores (pre-test) were analyzed, to
see the terminal behaviour (post-test) on two groups and the five criterion tests on five blocks were analyzed. The data was obtained by using the Appendix C (Achievement test, pre-test) and the Appendix AD (Comprehensive test, Post-test). The difference in the means of the two groups was tested for significance by applying the test. Effectiveness of the course content was compared block wise criterion test scores. The two groups mean difference were tested for significance by using 't' test.

4.2.2 Testing of Hypotheses

With reference to the first and second objectives that the course material was designed and developed by following systematic procedures and formative evaluation procedures by assessing the performance of distance learners of on criterion test at every block level and accordingly revising the self-instructional material to ensure that the course material is at the level of students.

Hypothesis 1

There is no significant difference between the mean scores of comprehensive test and that of combined criterion tests.

For studying the effectiveness of the course content, as a whole two indices, viz. mean scores on the comprehensive test and mean combined scores representing the performance on the five criterion test were obtained. To obtain the combined criterion test score, for each student the actual score on each test was converted into percentages; mean of these percentages over the five criterion tests represents the combined criterion test score for the particulars for the two groups were compared in respect to their mean comprehensive scores and the mean combined criterion test scores. The data obtained by using the Appendix T, V, X, Z and AB (Criterion tests) and the Appendix AD (Comprehensive test).

In order to test the above hypothesis, t-test was used. The results are shown in the following table.

*Table 4.2: t-test for the mean scores of comprehensive test and that of combined criterion tests*

<table>
<thead>
<tr>
<th>Performance</th>
<th>Combined Criterion Test</th>
<th>Comprehensive Test</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Achievement test</td>
<td>71.47</td>
<td>4.51</td>
<td>71.54</td>
</tr>
<tr>
<td>(N=100)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ns- Not significant at 0.05 level
From the table 4.2, it is observed that, the two means of combined criterion test (71.47) and comprehensive test (71.54) almost same. The calculated ‘t’ value (0.95) is less than the table value (2.53). There is no significant difference on the scores of comprehensive and that of combined criterion tests with 99 degrees of freedom (df) at 0.05 level. The null hypothesis accepted as there is no significant difference between the mean scores of comprehensive test and that of combined criterion tests.

It shows that the course content as a whole is an effective.

With regard to the third and fourth objectives that the following Null hypotheses are formulated

Hypothesis 2

There is no significant difference between pre-test and post-test mean scores of (Experimental Group) students of Non-formal stream (below SSC, SSC, Intermediate failed) and students of formal stream Intermediate qualification without Mathematics taught through Self-Instructional Course Material.

In order to test the above hypothesis, t-test was used. The results are shown in the following table. The data obtained by using the Appendix C (Pre-test) and appendix AD (Post-test).

Table 4.3: t-test for students of Non-formal and formal stream (Experimental Group) with respect to achievement in mathematics on pre-test and post test scores.

<table>
<thead>
<tr>
<th>Group</th>
<th>(Pre-test)</th>
<th>(Post-test)</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
</tr>
<tr>
<td>Experimental (N=50)</td>
<td>15.18</td>
<td>6.46</td>
<td>35.88</td>
</tr>
</tbody>
</table>

* Significant difference at 0.05 level

From the above table 4.3, it is clear that the mean of post-test scores is (35.88) with respect to achievement in mathematics is very high than the mean of pre-test scores (15.18). The calculated t-value is (3.67) is greater than the table value (2.53) at 0.05 level with degrees of freedom (df) 98. Therefore, there is significant difference in pre-test and post-test scores with respect to achievement test in mathematics. Therefore, the null hypothesis is rejected and accepted an alternate hypothesis is that, there is significant difference between pre-test and post-test mean scores of (Experimental Group) students of Non-formal stream (below SSC, SSC, Intermediate failed) and students of formal stream Intermediate qualification without Mathematics taught through Self-Instructional Course Material.
From the result, in pre-test, the experimental group performance is low, because the reason could be the non-formal stream students do not familiar with simple concepts in mathematics. Formal stream Intermediate qualification without Mathematics students also contributed in this group. These students could not be interested in learning mathematics or they could be failed in learning mathematics at their school level. After the treatment the same group performed well. Therefore, the investigator declared that the developed course material reached to the target learners in understanding the mathematical concepts. As a result, the purpose and main objective of the study was realized.

**Hypothesis 3**

There is no significant difference between mean scores of experimental [Students of Non-formal stream (below SSC, SSC, Inter failed, and Intermediate without Mathematics) and students of Formal Stream Intermediate qualification without Mathematics] and Reference [Students of formal stream Intermediate qualification with Mathematics] groups in the achievement test in Mathematics.

Effectiveness of the course content was compared block wise criterion test scores. The two groups mean difference were tested for significance by using ‘t’ test. Mean achievement scores for the groups on the five criterion tests are presented in table 4.4. The data was obtained by using the Appendix T, V, X, Z, and AB (Criterion Test 1, 2, 3, 4 and 5).

In order to test the above hypothesis, t-test was used. The results are shown in the following table.
Table 4.4: Comparison of the criterion test scores of two groups

<table>
<thead>
<tr>
<th>Block</th>
<th>Group</th>
<th>Mean</th>
<th>SD</th>
<th>t-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block I</td>
<td><em>Experimental Group (N=50)</em></td>
<td>35.40</td>
<td>2.91</td>
<td>0.17</td>
</tr>
<tr>
<td></td>
<td><em>Reference Group (N=50)</em></td>
<td>36.34</td>
<td>3.95</td>
<td></td>
</tr>
<tr>
<td>Block II</td>
<td><em>Experimental Group (N=50)</em></td>
<td>38.40</td>
<td>3.54</td>
<td>3.61*</td>
</tr>
<tr>
<td></td>
<td><em>Reference Group (N=50)</em></td>
<td>32.94</td>
<td>2.14</td>
<td></td>
</tr>
<tr>
<td>Block III</td>
<td><em>Experimental Group (N=50)</em></td>
<td>38.60</td>
<td>3.16</td>
<td>1.23</td>
</tr>
<tr>
<td></td>
<td><em>Reference Group (N=50)</em></td>
<td>33.86</td>
<td>2.27</td>
<td></td>
</tr>
<tr>
<td>Block IV</td>
<td><em>Experimental Group (N=50)</em></td>
<td>33.44</td>
<td>1.95</td>
<td>1.64</td>
</tr>
<tr>
<td></td>
<td><em>Reference Group (N=50)</em></td>
<td>36.52</td>
<td>3.98</td>
<td></td>
</tr>
<tr>
<td>Block V</td>
<td><em>Experimental Group (N=50)</em></td>
<td>34.00</td>
<td>1.65</td>
<td>1.11</td>
</tr>
<tr>
<td></td>
<td><em>Reference Group (N=50)</em></td>
<td>37.86</td>
<td>3.70</td>
<td></td>
</tr>
</tbody>
</table>

* Significant difference at 0.05 level

From the table 4.4, it is observed that on the tests for block I, block II, block III, block IV and the block V. The mean achievement scores do not differ significantly at 0.05 level except block II. The mean achievement scores for the block I do not differ significantly. The performance of the two groups on criterion test for block I was done almost same. The means of experimental and reference group are (35.40) and (36.34) respectively. The calculated ‘t’ value for block I is 0.17 which is less than the table value (2.53) with 98 degrees of freedom (df) at 0.05 level.

For block II the mean scores differ significantly at 0.05 level in favour of the experimental group which learnt through the course content. The means of experimental group for block II is (38.40) higher than that the means of reference group are (32.94). For block III, IV and V the mean scores do not differ significantly at 0.05 level. The means of reference group for block III, IV and V are (33.86), (36.52) and (37.86) and the means of experimental group are (38.60), (33.44) and (34.00) respectively. The experimental group had better performance for bock III, while the reference group had better performance for block IV and V. The calculated ‘t’ value for block III, IV and V are (1.23), (1.64) and (1.11) respectively are less than the table value (2.53) with 98 degrees of freedom (df) at 0.05 level. Therefore, the null hypothesis was accepted as there is no significant difference between mean scores of experimental [Students of Non-formal stream (below SSC, SSC, Inter failed, and Intermediate without Mathematics) and students of Formal Stream Intermediate
qualification without Mathematics] and Reference [Students of formal stream Intermediate qualification with Mathematics] groups in the achievement test in Mathematics.

The results reveal that, the developed course content reached the target learners those who do not have mathematics at their formal education and those admissions made through Eligibility Test. Over all out of five criterion tests, the reference group showed better performance on three tests, and the experimental group showed better performance on two tests. It reveals that, the developed course content has the internal validity. Thus it shows that the self-Instructional Course Material in Mathematics is equally effective with that of the Course Material studied by Intermediate students with Mathematics.

4.3 CONCLUSION

In the present chapter, the performance of the experimental group [post-test scores] in the achievement test in Mathematics was better when compared with pre-test scores of the distance learners taught through Self-Instructional Course Material. Further, the results show that the self-Instructional Course Material in Mathematics is equally effective when the performance of experimental group was compared with that of the reference group i.e. Intermediate students with Mathematics.

In the present chapter, the analysis of the data during the course development reveal that, there is no significant difference on the scores of comprehensive and that of combined criterion tests. It shows that the course content as a whole is effective and students’ comprehensive level.