Chapter IV
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CHAPTER IV

RESEARCH DESIGN AND METHOD OF INVESTIGATION

4.0 Introduction

A careful and detailed analysis of the research procedure including the design of the study, a description of the preparation and validation of the tools used in the study, the selection of the sample, the collection of the data, the scoring procedures and the statistical treatment employed for the analysis of the data is presented in this chapter.

4.1 Main Objectives of the Study

After considering the theoretical perspectives, the conceptual framework and review of the related literature, the following objectives were formulated to seek answers to the research questions given in Chapter I.

i) To explore whether teacher trainees in the colleges of education differ in a) mastery in subject content of high school Biology b) problem solving ability c) teaching aptitude d) performance in science at degree level and e) teaching competency owing to variations in the personal variables namely, gender, region, qualification of the teacher trainees, college management type, education of father, education of mother, occupation of father, occupation of mother and parental income.

ii) To investigate the relationship between the variables, namely, a) mastery in subject content of high school Biology, b) problem solving ability, c) teaching aptitude, d) performance in science at degree level and e) teaching competency.
iii) To examine the relationship between components of teaching competency, and a) mastery in subject content of high school Biology, b) problem solving ability, c) teaching aptitude, and d) performance in science at degree level.

iv) To find the relationship between components of teaching aptitude and a) mastery in subject content of high school Biology, b) problem solving ability, c) performance in science at degree level, d) teaching competency.

v) To predict teaching competency of the teacher trainees in terms of a linear combination of a) mastery in subject content of high school Biology, b) problem solving ability, c) teaching aptitude and d) performance in science at degree level.

vi) To predict teaching competency of the teacher trainees in terms of a linear combination of components of teaching aptitude.

vii) To predict the teaching competency of the teacher trainees in terms of a linear combination of selected personal variables and a) mastery in subject content of high school Biology, b) problem solving ability, c) teaching aptitude and d) performance in science at degree level.

viii) To explore which of the selected variables effectively discriminate between high competent and low competent teacher trainees.

ix) To construct and validate a model of causal relationship among the selected personal variables, mastery in subject content of high school Biology, performance in science at degree level, teaching aptitude, problem solving ability and teaching competency of the teacher trainees.
4.2 Hypotheses

Keeping the above objectives in view, the following hypotheses were formulated.

H1 Teacher trainees in the colleges of education differ in i) mastery in subject content of high school Biology, ii) problem solving ability, iii) teaching aptitude, iv) performance in science at degree level and v) teaching competency owing to variations in a) gender b) region, c) qualification of the teacher trainees, d) college management type e) education of father, f) education of mother, g) occupation of father h) occupation of mother and i) parental income

H2.1 There is significant relationship between
i) mastery in subject content of high school Biology and
   a) problem solving ability                  c) performance in science at degree level
   b) teaching aptitude                        d) teaching competency

   ii) Problem solving ability and
       a) mastery in subject content of high school Biology  c) performance in science at degree level
       b) teaching aptitude                           d) teaching competency

   iii) teaching aptitude and
       c) mastery in subject content of high school Biology  c) performance in science at degree level
       a) problem solving ability                      d) teaching competency

   iv) performance in science at degree level and
       a) mastery in subject content of high school Biology  c) teaching aptitude
       b) problem solving ability                      d) teaching competency
v) teaching competency and
   a) mastery in subject content  
   b) problem solving ability  
   c) performance in science at degree level  
   d) teaching aptitude

$H_{2.2}$ There is significant relationship between components of teaching competency and
   a) mastery in subject content  
   b) problem solving ability  
   c) performance in science at degree level  
   d) teaching aptitude

$H_{2.3}$ There is significant relationship between components of teaching aptitude and
   a) mastery in subject content  
   b) problem solving ability  
   c) performance in science at degree level  
   d) teaching competency

$H_{3.1}$ A linear combination of the variables namely mastery in subject content of high school Biology, problem solving ability, teaching aptitude and performance in science at degree level significantly predicts teaching competency.

$H_{3.2}$ A linear combination of components of teaching aptitude significantly predicts teaching competency.

$H_{3.3}$ A linear combination of all the selected personal variables in the study and the variables namely mastery in subject content of high school Biology, problem solving ability, teaching aptitude and performance in science at degree level significantly predicts teaching competency.
H4 All the selected personal variables and the variables namely mastery in subject content of high school Biology, problem solving ability, teaching aptitude and performance in science at degree level together discriminate the high competent and low competent teacher trainees.

4.3 Design of the Study

Design is the heart of any research. "A research design is the arrangement of conditions for collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy in procedure" (Selltiz, et. al 1962, p.50). In fact, the research design is the conceptual structure within which research is conducted. It constitutes the blue print for the collection, measurement and analysis of the data.

Best (1983) states that "descriptive research sometimes known as non-experimental research deals with the relationship between variables, testing of hypothesis and development of generalization of principles or theories that have universal validity. It is concerned with the functional relationship" (p.106). Hence the present study "Problem Solving Ability, Aptitude and Competency in Teaching Science of trainees in Colleges of Education in Kerala" has been designed as a descriptive study.

4.4 Tools used for the Study

The following tools were used for the present investigation.

i) A test on Mastery in Subject Content of High School Biology developed by the investigator.

ii) Problem Solving Ability Test devised by the investigator.

iii) An adapted version of the standardized General Teaching Competency Scale (GTCS) prepared by Passi and Lalitha (1979).
iv) Teaching Aptitude Test Battery (TATB) prepared and standardized by Karim and Dexit (1986).

v) The marks secured by the teacher trainees in science in their B.Sc Degree Examination conducted by the University as recorded in the college register.

vi) Personal Data Sheet to collect the data on selected personal variables.

4.4.1 Development of Test on Mastery in Subject Content of High School Biology (Tool No.1)

4.4.1.1 Selection of the Units

This test was designed to measure the mastery in subject content of high school Biology of teacher trainees who had opted for natural science. Since most of the Biology teacher trainees after their training will be joining secondary schools as science teachers, it was thought appropriate to test the teacher trainees' content knowledge in Biology syllabus prescribed for high school classes. Before the units were selected, the investigator made a detailed study of the entire Biology syllabus and text books for classes VIII, IX and X prescribed by the Govt. of Kerala so as to identify the important and fundamental concepts. Biology syllabus of classes VIII, IX and X are divided into 6 units, 10 units and 7 units respectively. Since some of these units were repeated, the researcher in consultation with the experienced teachers of Biology and subject experts selected 13 units. Care was taken not to avoid any of the units from the prescribed syllabus.

4.4.1.2 Construction of the Test

4.4.1.2.1 Preliminary Draft of the Test

After identifying 13 units, the investigator planned to develop a suitable test to examine the extent to which the teacher trainees have mastered the
content. Mastery in subject content means total concept mastery or mastery of abilities and skills underlying the concepts. These have to serve the purpose of measuring the attainment of the students in selected areas of learning. Therefore an achievement test was constructed by preparing a blue print so as to allot appropriate weightage to different instructional objectives and different parts of the content. The weightage assigned to objectives and parts of the content are presented in tables 4.1 and 4.2.

Table 4.1
Weightage given to Instructional Objectives

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Objectives</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Knowledge</td>
<td>11</td>
<td>27.5</td>
</tr>
<tr>
<td>2.</td>
<td>Understanding</td>
<td>15</td>
<td>37.5</td>
</tr>
<tr>
<td>3.</td>
<td>Application</td>
<td>10</td>
<td>25</td>
</tr>
<tr>
<td>4.</td>
<td>Skill</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>40</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4.2
Weightage given to Content Area

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Content</th>
<th>Marks</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The cell</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>2.</td>
<td>Excretion</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>3.</td>
<td>Environmental Pollution</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>4.</td>
<td>Interdependence in Living World</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>5.</td>
<td>Reproduction and Growth</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>6.</td>
<td>Heredity and Variation</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>7.</td>
<td>Health and Hygiene</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>8.</td>
<td>Sense Organs</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>9.</td>
<td>Control and Co-ordination</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>10.</td>
<td>Chemical Co-ordination</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>11.</td>
<td>Organic Evolution</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>12.</td>
<td>Economic Importance of Plants and Animals</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td>13.</td>
<td>First Aid</td>
<td>1</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>40</td>
<td>100</td>
</tr>
</tbody>
</table>
To ensure the objectivity of scoring and to test the attainment of selected instructional objectives multiple choice type test items were thought to be more effective than other types of test items. Therefore the investigator developed 40 multiple choice test items as per the requirement of the blue print so that each item represents one of the cells of the blue print (blue print of the test is given in Appendix E).

The preliminary draft of the test with 40 items was given to 25 subject experts including teacher educators and experienced Biology teachers for their expert comments and opinions. They were asked to rate the items on a five point scale as i) excellent ii) good iii) average iv) poor and v) very poor as to their content accuracy, specifications and effectiveness of the suggested distractors. Four items that were rated as poor were further modified, taking care to construct the items of the same difficulty level and measuring the same instructional objectives. The rating of the test items by the subject experts is given in Appendix F. Thus the test was finalized.

4.4.1.2.2 Pilot Study

The initial version of the test was given to 100 teacher trainees selected at random from 4 different colleges of education in Kerala to find out whether the items are clear, inambiguous and easily comprehensible to the student teachers. All the items were found to be clear inambiguous and easily comprehensible by 94 per cent of the students teachers.
4.4.1.2.3 Final Format of the Test

The final version of the test contained 40 items distributed over knowledge, understanding, application and skill. 40 minutes duration was found to be sufficient to complete the test (A copy of the test is given in Appendix - A).

4.4.1.3 Reliability of the Test

The split half reliability was worked out for the test, using the data collected from 100 teacher trainees selected at random from different colleges of education in Kerala. The correlation coefficient was calculated and corrected for shortening the test, using Spearman-Brown formula. The reliability coefficient was found to be .69 indicating high reliability of the test.

4.4.1.4 Validation of the Test

The tool has been developed using a blue print with appropriate weightage given to different units of the content and different instructional objectives. Content validity of the tool was ensured by jury opinion. Jury comprised a panel of judges consisting of subject experts in the field, teacher educators and experienced high school teachers handling Biology. They were of opinion that the tool developed by the investigator is a satisfactory one for assessing mastery in subject content of the teacher trainees in high school Biology.

4.4.1.5 Administration of the Test and Scoring Procedure

Directions for answering the test items were given in the question paper itself. The teacher trainees were instructed to read the item carefully and mark the right answer in the answer sheet provided to them. The correct answer was given 1 mark and wrong answer was given 0. The total number of correct
answers indicated the score of the students in mastery in subject content of high school Biology.

4.4.2 Problem Solving Ability Test (Tool No. 2)

4.4.2.1 Construction of the Problem Solving Ability Test

Domain specific knowledge is important in solving problems, pertaining to a particular discipline. Therefore to measure the problem solving ability of the teacher trainees in science, the investigator had to select and restrict the areas (domains) for constructing the problems. This was done by indentifying domains which are interesting, relevant and applicable to life situations and classroom instruction. It was also thought reasonable to include current issues like environmental hazards and pollution and modern areas of research such as Genetic Engineering and Cloning as the domain bases for problem solving. Biology teacher trainees must be familiar with current issues and advancements in Biological science so that as future teachers they were able to share such information with their students.

Since problem solving is a scientific method requiring the formulation of a hypothesis and testing the hypothesis for validity, it was thought appropriate to construct problems testing these two important aspects of problem solving. Questions were drafted in such a way that the teacher trainees had to find out an inference which is most appropriate for the given problem. This inference was tested in the light of an appropriate rationale which will logically support the inference drawn by the testee. In order to find out such problems in Biology, which can meet the goal, the investigator made an indepth study of the B.Sc.
portions especially on the selected areas in Biology. Few examples of the problems are given below.

Eg. 1. Two sets of parents Mr X and Mrs X and Mr Y and Mrs Y claimed the same baby. Blood test gives the information that Mr X and Mrs X belong to blood group A. Mr Y belongs to blood group O and Mrs Y of blood group AB. The child belongs to blood group O.

A. Which of the following inference is correct?

Parents of the child is
a) Mr X and Mrs X
b) Mr Y and Mrs Y
c) Either Mr X and Mrs X or Mr Y and Mrs Y
d) None of the above couples

B Choose the best answer among the listed alternatives which will support the answer you have chosen.

a) Genotype of Mr X and Mrs X have homozygous chromosomes
b) Genotype of Mr Y will be ii and that of Mrs Y will be $I^A I^B$
c) Genotype of both couples has ii.
d) Genotype of Mr X and Mrs X have either $I^A i$ or $I^A I^A$
e) Genotype of Mr Y will contribute chromosome for O group blood in the next generation.

Eg. 2 Cloning becomes more potent when allied to the rapid advances being made in the field of medicine. What would be the hazard in the nearby future if cloning becomes successful in producing progeny in human beings?
A. Which the following inferences is correct?

a) There are chances of variation between parents and progeny
b) The process of cloning results in the break down of healthy parental relationship
c) More parents will go for cloning
d) The surrogate mothers will be giving birth to her child which is the true replica of somatic cell

B Choose the answer which will support the answer you have chosen

a) Parents have to depend on the diploid somatic cells for the production of the progeny
b) Genetic constitution of a clone will be the exact replica of the donor cell.
c) The process of fertilization is found not necessary for cloning
d) In the process of cloning there is no critical role for male gametes and female gametes in the production of human embryos.
e) Parents may depend on others for the somatic cells if their genetic constitution is not good.

A preliminary draft with 22 items were given to subject experts and the questions were modified as per suggestions given by them. The items which were found to be too easy or too difficult were deleted. Accordingly 20 items which were relevant and appropriate for the purpose were included in the initial version of the test. Table 4.3 shows the number of problems covering each topic for the preliminary draft and final study.
Table 4.3

Topicwise Distribution of Problems in Preliminary Draft and Main Study

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Area</th>
<th>Preliminary Draft</th>
<th>Main Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Elements of Heredity and Variation</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>Environmental Pollution</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Control and Co-ordination</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Human diseases and Immunity</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Applications of Biology</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>Gene expression and its Regulation</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>Genetic Engineering and Cloning</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>Plant growth</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>Sense organs</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Connective tissue</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

4.4.2.2 Pilot Study

The initial draft of the test was administered to a group of 100 teacher trainees randomly drawn from 4 different colleges of education in Kerala. Based on their performance and comments of the judges, some problems were restructured. The time taken by the students to do the test was noted down.

4.4.2.3 Final Format of the Test

The final format of the test contains 20 problems. 60 minutes time duration was found sufficient to complete the test (A copy of the test is given in Appendix-B).

4.4.2.4 Reliability of the Test

The reliability of the test was established by split half method. For this purpose, the test was administered to a sample of 100 teacher trainees randomly selected from 4 different colleges of education in Kerala. The correlation
coefficient was calculated and corrected for shortening the test, using Spearman Brown Formula. The reliability coefficient thus computed was .75 which indicates high reliability of the test.

4.4.2.5 Validation of the Test

The index of reliability is taken as a measure of validity (Garret, 1969). The validity was established through the reliability i.e. by $\sqrt{r^-}$. The square root of the reliability coefficient was computed as .86 which showed the test was found to be significantly valid.

4.4.2.6 Administration of the Test and Scoring Procedure

Directions for answering the test was given in the question paper itself. The teacher trainees had to find out an inference which is to be verified in the light of rationale which will support the inference taken. Hence they had to choose an inference which is most appropriate and a best answer which will support the answer that has been chosen.

The teacher trainees were asked to give their answers in a separate answer sheet provided to them. Each problem of the test was allotted two marks each, 1 mark for the inference and 1 mark for the best answer they have chosen to support the inference. The total score obtained by a student on this test was a measure of his or her problem solving ability in science.

4.4.3 General Teaching Competency Scale (GTCS) Tool No.3

An adapted version of the standardized General Teaching Competency Scale (GTCS) developed by Passi and Lalitha (1979) was used for measuring the
teaching competency of the teacher trainees. This scale consists of 21 items related to teaching skills which encompass the entire teaching learning process in the classroom. They are related to five major aspects of classroom teaching, namely, planning, presentation, closing, evaluation and managerial. The items were rated on a five-point scale, ranging from, not at all, poor, average, good and very good.

4.4.3.1 Components of General Teaching Competency Scale (GTCS)

The GTC Scale consists of five sub tests related to five major aspects of classroom teaching, viz., planning, presentation, closing, evaluation and managerial. The various teaching skills included are related to objectives of the lesson, content selection, content organization, selection of the audio-visual materials (planning skills), introducing the lesson, fluency of questions, use of probing questions, explaining, illustrating with examples, stimulus variation, use of silence and non verbal cues, increasing pupil participation, use of black board (presentation skills), achieving closure, giving assignment (closing skills), classroom evaluation, diagnosis of pupil difficulties (evaluation skills) recognising attending behaviour and maintaining classroom discipline (managerial skills).

The distribution of various items related to five components of General Teaching Competency Scale are given in the Table 4.4 (A copy of the General Teaching Competency Scale is given in Appendix D).
Table 4.4

Distribution of Items Relating to Different Teaching Skills

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Teaching Skills</th>
<th>No. of Items</th>
<th>Serial No. of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Planning</td>
<td>4</td>
<td>1-4</td>
</tr>
<tr>
<td>2</td>
<td>Presentation</td>
<td>11</td>
<td>5-15</td>
</tr>
<tr>
<td>3</td>
<td>Closing</td>
<td>2</td>
<td>16, 17</td>
</tr>
<tr>
<td>4</td>
<td>Evaluation</td>
<td>2</td>
<td>18, 19</td>
</tr>
<tr>
<td>5</td>
<td>Managerial</td>
<td>2</td>
<td>20, 21</td>
</tr>
</tbody>
</table>

4.4.3.2 Inter Observer Reliability

"The correlation between scores based on observations made by different observers at the same time will be referred to as a coefficient of observer agreement" (Medley and Mitzel, 1965 p.253).

The reliability of the scale was established by Inter Rated Method or Inter Observer Reliability Method. To find out the interobserver reliability, 100 teacher trainees from 4 different colleges of education were randomly selected. Rating on teaching competency of these teacher trainees were done by two teacher educators: i) the biology teacher educator of the same college and ii) the investigator. These two observers sat at two different places where they could observe teacher behaviour without any interruption and made independent rating using GTC Scale. The correlation coefficient of these two sets of scores was found to be 0.85 indicating the high reliability of the tool.
4.4.3.3 Validity of the GTC Scale

The content validity and factorial validity of the GTC Scale were already established by Passi and Lalitha (1979). In order to ensure the content validity of the tool, while constructing the scale, the tool makers had held frequent consultations with teachers and teacher educators. The factorial validity of the scale was established by Rama (1979) in her doctoral study on factorial structure of teaching competencies among secondary school teachers (Manual for GTCS).

However the investigator established the concurrent validity of the scale by considering its relationship with other concurrently (simultaneously) obtainable information about the teacher trainees. 100 teacher trainees who had opted for Natural Science from 4 different colleges of education were randomly selected for the purpose. Marks obtained for teaching competency during teaching practice was collected from the records maintained in the respective colleges. The calculated correlation coefficient between the marks obtained for teaching practice and the marks obtained on GTCS observation schedule was .69 showing high positive correlation between the two scores. Thus the tool has significant validity.

4.4.3.4 Administration of the GTC Scale and Scoring Procedure

The GTC Scale is a classroom observation schedule on teaching competency. The observer rates the teaching competency of each teacher trainee as he/she teaches the class. The rating is done by giving a tick mark (✓) in the space provided for each item in the GTCS.
For the purpose of scoring, scores ranging from 1 to 5 were allotted to the rating ranging from not at all, poor, average, good and very good. The sum of ratings against planning skills, presentation skills, closing skills, evaluation skills and managerial skills were added up. The sum total of the ratings of these components of GTC Scale constitute the total teaching competency score.

4.4.4 Teaching Aptitude Test Battery (TATB) (Tool No. 4)
The standardized tool “Teaching Aptitude Test Battery” (TATB) prepared by Karim and Dixit (1986) was used for assessing the teaching aptitude of the teacher trainees. This battery consists of 80 items relating to 8 dimensions, containing 8 sub tests. Each sub test consists of 10 items relating to the area specified. The distribution of items relating to the eight dimensions is shown in Table 4.5.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Dimensions</th>
<th>Serial No. of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Co-operative nature</td>
<td>1-10</td>
</tr>
<tr>
<td>2</td>
<td>Considerativeness</td>
<td>1-10</td>
</tr>
<tr>
<td>3</td>
<td>Wide interest and Scholarly taste</td>
<td>1-10</td>
</tr>
<tr>
<td>4</td>
<td>Fairmindedness and Impartiality</td>
<td>1-10</td>
</tr>
<tr>
<td>5</td>
<td>Moral character and Discipline</td>
<td>1-10</td>
</tr>
<tr>
<td>6</td>
<td>Optimistic Attitude</td>
<td>1-10</td>
</tr>
<tr>
<td>7</td>
<td>Motivational Aspect</td>
<td>1-10</td>
</tr>
<tr>
<td>8</td>
<td>Dynamic Personality</td>
<td>1-10</td>
</tr>
</tbody>
</table>

4.4.4.1 Reliability of the Teaching Aptitude Test Battery
The reliability of the tool as given in the manual is .91. However the investigator established the reliability of the tool by test retest method. For this
purpose the investigator administered the teaching aptitude test battery twice for a sample of 100 Biology teacher trainees randomly selected from 4 different colleges of education in Kerala with a time lapse of two weeks. The coefficient of correlation between the two sets of scores was found to be .96 indicating the high reliability of the test battery.

4.4.4.2 Validity of the Teaching Aptitude Test Battery

The square root of the reliability coefficient is a measure of the validity of the tool (Garret, 1969). Therefore the validity of the tool was found by computing the square root of the coefficient of reliability and it was found to be .98 indicating the high validity of the test battery.

4.4.4.3 Administration of the Tool and Scoring Procedure

Directions for responding to the test battery was given in the tool itself. The respondents had to read the statements given in the test battery carefully. These statements were followed by three types of responses – Agree, Doubtful, Disagree. They had to mark their response by giving a tick (✓) mark in the box provided in the answer sheet.

For the purpose of scoring, 3 marks were given to ‘agree’ responses, 2 marks to each doubtful response and 1 mark to each ‘disagree’ response. For getting the total score, each response mark of a given statement was added for each sub test and the sum total of all sub tests were calculated. The total score obtained by a teacher trainee on this test was taken as a measure of his or her aptitude for teaching.
4.4.5 Performance in Science at Degree Level

The total marks secured in science by the teacher trainees in their B.Sc Degree Examination conducted by the University as recorded in the college register were taken as the score for performance in science at degree level.

4.4.6 Personal Data Sheet

The Personal Data Sheet was designed to collect the data on the personal variables. Information was sought on the personal details of the teacher trainees on selected factors like gender, region, parents’ education, parents’ occupation, parental income, qualification of the teacher trainees, college management type etc (See Appendix C for a copy of the Personal Data Sheet).

4.5 Sample for the Main Study

It is to be noted that an optimum sample fulfils the requirements of the representation and reliability. The sample should be sufficiently large to minimize sampling error. Garret (1969) in this regard points out, “the larger the N, the larger the SD of the sample and the more inclusive (and presumably representative) our sample becomes of the general population” (p.208). In the present study cluster sampling was used to select the sample from the randomly selected 34 colleges of education. The sampling units were in clusters i.e. the data was collected from all the teacher trainees who had opted for Natural Science (complete count of all the items) from 34 colleges of education. Thus a sample of 756 teacher trainees (Natural Science) of regular B.Ed course admitted to 34 colleges of education for the year 2003-2004 affiliated to different universities in Kerala constituted the sample for the present study. Though a
sample size of 800 was aimed at, due to incomplete details and absentees and delay in getting back teaching competency tool from two colleges, the sample size was reduced to 756. Deliberate attempt was made to select colleges affiliated to different universities and from different districts of Kerala. The district and university-wise distribution of the sample is given in Table 4.6.

<table>
<thead>
<tr>
<th>Sl. No</th>
<th>Affiliated University</th>
<th>District</th>
<th>No. of Colleges</th>
<th>Sample Size</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>1</td>
<td>Mahatma Gandhi University</td>
<td>Kottayam</td>
<td>6</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pathanamthitta</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ernakulam</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Calicut University</td>
<td>Malappuram</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kozhikode</td>
<td>4</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Palakkad</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thrissur</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Kerala University</td>
<td>Pathanamthitta</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kollam</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Kannur University</td>
<td>Kannur</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>34</td>
<td>78</td>
</tr>
</tbody>
</table>

The sample was selected from government, aided and unaided colleges of education in Kerala. Survey shows only few male teacher trainees were getting enrolled into teaching profession in Natural Science and hence the number of male teacher trainees in the sample was found to be very few (78) compared to female teacher trainees (678). The selected personal variables and their categories are shown in Figure 4.1.

4.5.1 Distribution of the Sample according to Various Categories and Subcategories

Table 4.7 presents the distribution of the sample according to various categories and sub categories of selected variables.
### Table 4.7
Distribution of the Sample according to Various Categories and Sub Categories

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sub Categories</th>
<th>Size</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td>Male</td>
<td>78</td>
<td>10.3</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>678</td>
<td>89.7</td>
</tr>
<tr>
<td><strong>Region</strong></td>
<td>Rural</td>
<td>600</td>
<td>79.4</td>
</tr>
<tr>
<td></td>
<td>Urban</td>
<td>156</td>
<td>20.6</td>
</tr>
<tr>
<td><strong>Qualification of the</strong></td>
<td>Graduate</td>
<td>503</td>
<td>66.5</td>
</tr>
<tr>
<td><strong>Teacher Trainees</strong></td>
<td>Post Graduate</td>
<td>253</td>
<td>33.5</td>
</tr>
<tr>
<td><strong>College Management</strong></td>
<td>Govt./Uty Centre*</td>
<td>160</td>
<td>21.16</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Aided</td>
<td>332</td>
<td>43.92</td>
</tr>
<tr>
<td></td>
<td>Unaided</td>
<td>264</td>
<td>34.92</td>
</tr>
<tr>
<td><strong>Socio Economic Status</strong></td>
<td>High</td>
<td>181</td>
<td>23.94</td>
</tr>
<tr>
<td></td>
<td>Average</td>
<td>396</td>
<td>52.38</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>179</td>
<td>23.68</td>
</tr>
<tr>
<td><strong>Education of Father</strong></td>
<td>Less than SSLC</td>
<td>35</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>SSLC</td>
<td>275</td>
<td>36.4</td>
</tr>
<tr>
<td></td>
<td>PDC</td>
<td>194</td>
<td>25.7</td>
</tr>
<tr>
<td></td>
<td>Graduate</td>
<td>148</td>
<td>19.6</td>
</tr>
<tr>
<td></td>
<td>Post Graduate/Professional</td>
<td>104</td>
<td>13.75</td>
</tr>
<tr>
<td><strong>Education of Mother</strong></td>
<td>Less than SSLC</td>
<td>78</td>
<td>10.3</td>
</tr>
<tr>
<td></td>
<td>SSLC</td>
<td>290</td>
<td>38.4</td>
</tr>
<tr>
<td></td>
<td>PDC</td>
<td>214</td>
<td>28.3</td>
</tr>
<tr>
<td></td>
<td>Graduate</td>
<td>103</td>
<td>13.6</td>
</tr>
<tr>
<td></td>
<td>Post Graduate/Professional</td>
<td>71</td>
<td>9.3</td>
</tr>
<tr>
<td><strong>Occupation of Father</strong></td>
<td>Unemployed</td>
<td>160</td>
<td>21.2</td>
</tr>
<tr>
<td></td>
<td>Daily Earners</td>
<td>105</td>
<td>13.9</td>
</tr>
<tr>
<td></td>
<td>Semi Skilled Workers</td>
<td>61</td>
<td>8.1</td>
</tr>
<tr>
<td></td>
<td>Regular Employee</td>
<td>227</td>
<td>30.0</td>
</tr>
<tr>
<td></td>
<td>Businessman</td>
<td>160</td>
<td>21.2</td>
</tr>
<tr>
<td></td>
<td>Executive/Professional</td>
<td>43</td>
<td>5.68</td>
</tr>
<tr>
<td><strong>Occupation of Mother</strong></td>
<td>House wife</td>
<td>620</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>Daily Earners</td>
<td>17</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>Semi Skilled Workers</td>
<td>11</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>Regular Employee</td>
<td>71</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>Executive/Professional</td>
<td>37</td>
<td>4.9</td>
</tr>
<tr>
<td><strong>Parental Income</strong></td>
<td>Less than Rs.1000</td>
<td>83</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Rs.1001-Rs.5000</td>
<td>305</td>
<td>40.4</td>
</tr>
<tr>
<td></td>
<td>Rs.5001-Rs.10,000</td>
<td>224</td>
<td>29.7</td>
</tr>
<tr>
<td></td>
<td>Above Rs.10,000</td>
<td>144</td>
<td>18.9</td>
</tr>
</tbody>
</table>

* Uty Centre – University Centre
Figure 4.1

Sample Distribution According to the Selected Personal Variables and their Categories
4.6 Collection of the Data

The collection of the data was done in two stages. The investigator selected 36 colleges of education in Kerala by random sampling. The heads of institutions were contacted sufficiently earlier and permission was sought for collecting the data from teacher trainees who had opted for Natural Science.

In the first stage, the data was collected on mastery in subject content of high school Biology, problem solving ability, teaching aptitude, performance in science at degree level and personal variables. For this the investigator visited those colleges in person which were selected for the study in the month of October/Nov. 2003. After giving the proper instructions on how to fill it out, the test on Mastery in Subject Content of High School Biology and response sheets were distributed among the teacher trainees. The time allotted was 40 minutes. After completing the first test, the problem solving ability test was administered. Directions were given as to how the problems given should be responded. 60 minutes time duration was allotted for the proper application of the pertinent information to solve the problems given in Problem Solving Ability Test.

Personal data sheets were distributed among the teacher trainees to collect the personal details and information on the selected variables and were collected back after 10 minutes. The Teaching Aptitude Test Battery along with separate answer sheets were distributed and teacher trainees were asked to give their responses for each question in the answer sheets provided. After 30 minutes, the answer sheets along with the Test Battery were collected back.
In order to assess the teaching competency of the teacher trainees, the teacher educator handling Biology was thought to be the most appropriate person, as the teacher educator is the expert on teaching skills and will be able to distinguish between the various teaching skills. Moreover, the teacher educator is constantly interacting with the teacher trainees, and hence he or she will be able to provide an accurate assessment of the teaching competency of his or her students. Therefore the assessment of the teaching competency was entrusted to the Biological Science teacher educator in the respective college of education. For this purpose the investigator met the biological science teacher educator personally in each college and instructions and orientation was given to each teacher educator as to how to use the general teaching competency scale for the effective assessment of the teaching competency. Each teacher educator observed 2 lessons of the teacher trainees during internship, one at the beginning and one towards the end of the teaching practice. The average of the two scores was taken as the score for the teaching competency of the teacher trainees.

The researcher visited the colleges of education for the second stage and collected the rating sheets. The data from 2 colleges were not complete as the biology teacher educator had some personal problems and hence the data collected from those two colleges on other variables were deleted. The final sample was 756 from 34 colleges of education from different Districts of Kerala.
4.7 Design for the Analysis of Data

4.7.1 Descriptive Analysis

In the initial analysis of the data, the teacher trainees were classified into various groups and subgroups on the basis of different selected variables. Arithmetic mean and SD were calculated for the whole sample as well as for sub samples.

4.7.2 Differential Analysis

Differential analysis using ‘F’ test (Analysis of Variance) and ‘t’ test were planned to test the differences of the sub groups in i) mastery in subject content of high school Biology ii) problem solving ability iii) teaching aptitude iv) performance in science at degree level and v) teaching competency.

4.7.3 Correlational Analysis

Pearson’s product moment correlations were selected to compute the relationship among the variables namely, i) mastery in subject content of high school Biology ii) problem solving ability iii) teaching aptitude iv) performance in science at degree level and v) teaching competency.

4.7.4 Multivariate Analysis

4.7.4.1 Regression Analysis

Multiple regression analysis was thought to be appropriate for testing whether teaching competency of the teacher trainees depend on a composite set of selected personal variables, mastery in subject content of high school Biology, problem solving ability, teaching aptitude and performance in science at degree level. Further regression analysis was useful for developing regression equations for predicting the teaching competency.
4.7.4.2 Discriminant Analysis

Discriminant function analysis was selected for discriminating between high and low competent teacher trainees.

4.7.4.3. Conceptualisation of a Path Model for Teaching Competency

The path model is a tool for examining empirical evidence and can be used to examine the causal processes within a system of variables. Though path analysis is not a procedure for demonstrating causality, it is possible to deal with the causality by using hypothetical ‘models’ in a survey research. To construct such a model, a limited number of variables are treated in a net work of causal relationships within it. (Pine, 1977). Hence a causal model maybe an attempt to portray causal relationship within a system of variables. The causal path model is used to describe, explain, or predict the presence and nature of relationships along with the direction of the causal influence (Pine, 1977). Path analysis entails the use of multiple regression in relation to explicitly formulated models. The pattern of relationship among the variables in the model can be examined using quantitative estimates of the causal connections between sets of variables.

One of the major advantages of path analysis is that it forces the statement of an explicit theory about relationship rather than simply testing a set of data for any linear relationship. It also produces a clear and explicit result of the strengths of the mathematical relationships contained within.
4.7.4.3.1 Proposed Path Model

Path analysis is a special use of multiple regression to help understand and parcel out the sources of variance. The proposed path model aims at providing estimates of the magnitude and significance of hypothesized connections between sets of variables. The variables considered in this relationship are i) teaching competency ii) performance in science at degree level iii) mastery in subject content of high school Biology iv) problem solving ability v) teaching aptitude vi) qualification of the teacher trainees vii) SES viii) region and ix) gender.

Teaching competency is the important dependent variable for which the relationship of all the other variables are to be estimated and a path model has been conceptualized. It is assumed that performance in science at degree level and mastery in subject content of high school Biology are achieved with the direct and indirect influences of problem solving ability, teaching aptitude and the personal variables like educational qualification, SES, region and gender of the individual teacher trainee.

The investigator assumed that the hypothesized variables in the path model may have direct or indirect effects on teaching competency. The innate abilities of teacher trainees may be influenced by basic personal variables selected for the study. The innate abilities within the teacher trainees as well as personal variables may directly or indirectly influence achievement variables as well as teaching competency of the teacher trainees. The achievement variables
may independently contribute towards teaching competency. Accordingly, path diagram is conceptualized in four different levels and the relative effect is drawn giving hypothesized connections between sets of variables within the net work of the path model.

Teaching aptitude may influence problem solving ability of the teacher trainees but problem solving ability need not influence teaching aptitude since it is a personality variable. Therefore while conceptualizing the path model, the investigator has given unidirectional path in the path model between teaching aptitude and problem solving ability. Among the personal variables selected, qualification of the teacher trainees is considered as a dependent variable and regression coefficients are found out to see the effect of gender, region and SES on qualification of the teacher trainees. Initially the investigator assumed gender, region and SES as basic personal variables and hence correlational analysis was done to find out the relationship between those three variables.

In this study, path model has been designed to study the causal effect of the personal variables and other variables selected in the study on teaching competency. The causal model is derived from the conceptual frame work for the present study in chapter II. The basic path model proposed for the present study is shown in Figure 4.2. This path model will be validated on the basis of the empirical evidences collected.
Figure 4.2

Schematic Representation of the Conceptualised Path Model for Teaching competency