RESEARCH METHODOLOGY

Research is a process of investigation and an examination of a subject from different points of view. It is a hunt for the truth. It is getting to know a subject by reading up on it, reflecting, playing with the ideas, choosing the areas that have interest and following up on them. A research design is a plan of action. It is a plan for collecting and analysing data in an economic, efficient and relevant manner. According to Bernad Philips, it is a ‘blue print for the collection, measurement and analysis of data.’ According to Kerlinger, ‘Research design is the plan, structure and strategy of investigation conceived so as to obtain answers to research questions and to control variance.’

‘Research is considered to be the more formal, systematic and intensive process of carrying on the scientific method of analysis. It involves a more systematic structure of investigation usually resulting in some sort of formal record of procedure and a report of results in conclusion.’ (John. W. Best)

‘Research is an honest, exhaustive, intelligent search for facts and their meanings or implications with reference to a given problem. It is the process of arriving at dependable solutions to problems through planned and systematic collection, analysis and interpretation of data. The best search is that which is reliable, verifiable and exhaustive, so that it provides information in which we have confidence.’ (P.M. Cook)
A major purpose of educational research is to provide evidence to help people decide which opinions are correct or at least more correct. Decisions affecting the greatest resource that human beings have, their children, should be informed by knowledge, not by the loudest voices that can be heard. A second purpose of the research is to develop better ways to impart education. Just as other forms of scientific research that have changed our conceptions of both physical world and our own psychological world, educational research can be expected to lead to more effective and efficient ways of schooling.

Further, a design is used to structure the research, and to show how all the major parts of the research project (samples or groups, measures, treatments or programs, and methods of assignment) will work together to address the central research questions.

A good design is often characterised by flexible, appropriate, efficient, economical procedure to conduct the study. Generally, the design, which minimises bias and maximises the reliability of the data collected and analysed, is considered a good design. The design which gives the smallest experimental error is supposed to be the best design in many investigations. Similarly, a design which yields maximum information and provides an opportunity for considering many different aspects of a problem is considered the most appropriate and efficient design in respect of many research problems. Thus, the question of good design in this study is related to the purpose of the study and also to the nature of the problem.

For the study of this problem as mentioned earlier, ‘a study of teaching effectiveness, teaching aptitude and attitude towards teaching
mathematics of prospective mathematics teachers.’ the most suitable method is descriptive research.

According to John W Best, ‘descriptive research, the fundamental research method of behavioural science, is concerned with prevailing conditions. In addition to the description, there is an element of interpretation of the meaning or significance of what is described.’ In this type of research, focus is on prevailing conditions. It deals with analysis, interpretation of the data which have been gathered for a specific purpose for the understanding and solution of the significant problems.

Keeping in view the advantages of the method and nature of the current research work, normative survey method has been chosen by the researcher. The normative survey method of investigation is very common in educational research, which attempts to describe and interpret what exists at present in the form of conditions, practices, processes, trends, effects, attitudes, beliefs, etc. It involves clearly defined problems and definite objectives. It requires expert and imaginative planning, careful analysis and interpretation of the data gathered and logical reporting of the findings. As such this method is adopted being more suitable for the purpose of investigation.

In normative survey method, the term ‘normative’ implies to the determination of normal or typical conditions or practices at present time and the term ‘survey’ indicates the gathering of the data regarding current conditions. The normative survey method is an organised attempt to analyse, interpret and report the present status of a social institution, group or area. Survey studies collect information on what exists, on what we
want, and on how to get there. The normative survey of research is generally designed to obtain permanent and specific information concerning the current status of phenomena and, whenever possible, to draw valid general conclusions from the facts discovered. It does not restrict itself only to fact finding but may often lead to research that results in the formulation of important principles of knowledge and solutions of significant problems concerning local, state, national and international issues.

George J. Mouly has said, ‘no category of educational research is more widely used than the type known variously as the survey, the normative survey, status and descriptive research. This broad classification comprises a variety of specific techniques and procedures, all similar from the standpoint of purpose – that is, to establish the status of the phenomenon under investigation.’

In survey method, the researcher selects a problem and identifies the variables to be studied. Then he searches for suitable tools to measure the identified variables. If the available tools do not satisfy the requirements of the research, he or she has to design and develop the tools on his or her own to measure the variables. Then he or she selects an adequate and representative sample from which he or she collect the required data. After collection of the data, he or she analyses the data using appropriate statistical techniques. Finally he or she tests the hypothesis he or she has formulated and draws valid conclusions.
OPERATIONAL DEFINITIONS OF KEY TERMS

An operational definition is a statement that describes how to measure a certain variable or how to define a certain term. It is intended to be practical and workable under the conditions of the study, although it may not be a scientifically valid definition. The operational definition is used extensively for abstract as well as physical concepts.

The operational definitions of the important terms used in the present study ‘A study of teaching effectiveness, teaching aptitude and attitude towards teaching mathematics of prospective mathematics teachers’ are discussed herewith.

Study

Study means an investigation of a subject or a process for gaining knowledge of the subject.

Teaching

Teaching is a system of actions intended to produce learning.

– Smith, 1960

Teaching is a form of interpersonal influence aimed at changing the behaviour potential of another person. – Gage, 1963

Teaching is defined as an interactive process primarily involving classroom talk which takes place between teacher and pupils and occurs during certain definable activities. – Amidon and Hough, 1967

Teaching refers to activities that are designed and performed to produce change in the student (pupil) behaviour. – Clarke, 1970
Teaching is the task of a teacher which is performed for the development of a child. -- Green, 1971.

In the present study the term ‘teaching’ refers to a series of actions through which a teacher attempts to bring desired behavioural changes in students. Through teaching, the manner of thinking, feeling and acting of students will be changed.

Teaching Effectiveness

According to Remmers (1952), ‘effectiveness is the degree to which an agent produces effects.’

According to the study reported by Stern, Stein, and Bloom (1956), ‘effectiveness is rather a standard of performance in a specific work situation that some individuals are said to manifest.’

According to Ryans (1950), ‘teaching is effective to the extent that the teacher acts in ways that are favourable to the development of basic skills, understanding work habits, desirable attitudes, value judgements and adequate personal adjustment of the pupils.’

In the Dictionary of Education, Good (1959) defined teaching effectiveness as ‘the ability and the interaction between the physical, intellectual and psychological interests of the student and some given subject content, the ability of the teacher to relate the learning activities to the development process of the learners and to their current and immediate interests and needs.’ In the same dictionary, Good defined teacher efficiency as ‘the degree of success of a teacher in performing instructional and other duties specified in his contract and demanded by the nature of his position.’
According to Dickson (1980), ‘teaching effectiveness is a demonstrated repertoire of competencies involved in (i) teaching plans and materials, (ii) classroom procedure, (iii) inter-personal skills and (iv) learner’s reinforcement, involvement reflected in teacher behaviour.’

Teaching effectiveness for our purpose is concerned with what a teacher does in the classroom in order to induce pupil learning. Defined thus, teaching effectiveness includes (i) such characteristic qualities of a teacher as he exhibits in the classroom with the intention that his pupils learn what he teaches, (ii) such actions of a teacher which he performs in the classroom as have the intention that his pupils learnt what he teaches. Therefore, in the present study, teaching effectiveness is limited to classroom activities.

In the present study, teaching effectiveness is operationally defined as ‘the degree to which the prospective mathematics teacher exhibits actions or strategies that are essential for an effective mathematics teacher as perceived by his supervisor, i.e., mathematics teacher educator in his teaching which induce pupil learning.’

In the present study teaching effectiveness of prospective mathematics teachers was measured by a rating scale developed for the purpose of the study.

**Aptitude**

According to Good (1959) as explained in the Dictionary of Education, aptitude is ‘a pronounced innate capacity for or ability in a given line of endeavour such as a particular art, school subject, or vocation.’
Warren's Dictionary of Psychology provides the most apt elucidation of the concept of aptitude. Aptitude is “a condition or set of characteristics regarded as symptomatic of an individual’s ability to acquire with training some (usually specified) knowledge, skill, or set of responses such as the ability to speak a language, to produce music, etc.”

Aptitude refers to a condition or set of characteristics indicative of an individual’s potentialities which are indicative of special abilities. This implies that an aptitude is not necessarily an entity, but rather a constellation of entities, the set of characteristics that enables a person to learn something may even be different from that which enables another person to learn the same thing.

In the present study, the word aptitude is used to refer to ‘a condition or set of characteristics regarded as symptomatic of an individual’s ability to acquire with training some knowledge, or skill or set of response, such as the ability to teach.’

**Teaching Aptitude**

Teaching aptitude refers to the aptitude for teaching. It refers to an individual's inborn capacities or potentialities which are indicative of some special abilities that are required for teaching job.

Teaching aptitude is the capacity to acquire proficiency with a given amount of training in teacher education. It refers to the capacity of an individual to be skilled in teaching, receiving formal or informal training.

In the present study, the teaching aptitude refers to the capacity of the student teacher to be skilled in teaching, receiving formal training in
teaching. It is a potential for acquiring certain teaching skills and pedagogical knowledge.

In the present study the teaching aptitude of prospective mathematics was measured by adopting the teaching aptitude test battery developed and standardised by Shamim Karim and Ashok Kumar Dixit.

**Attitude**

According to Allport (1935), ‘attitude is a mental or neutral state of readiness, organised through experiences exerting a directive or dynamic influence upon the individual’s response to all the objects and situations with which it is related.’

Thurston (1948) has defined attitude as ‘the degree of positive or negative affect associated with some psychological object.’ The psychological object, according to him, may be a person, an institution, a religion, a community, an ideal, a subject, a system, a political party or a minority community.

Guilford (1954) defined attitude as ‘a personal disposition is common to individuals, but possessed to different degrees, which impels them to react to objects, situations, or propositions, in ways that can be called favourable or unfavourable.’

In the words of Freeman (1965), ‘an attitude is a dispositional readiness to respond for certain situations, persons, or objects in a constant manner which has been learned and has become one’s typical mode of response.’
Attitude means the individual’s prevailing tendency to respond favourably or unfavourably to an object. Attitudes can be positive or negative.

In the present study, the term attitude is used to refer to a mental and neutral state of readiness organised through experience, exerting a dynamic influence upon the individual responses to subjects and situations with which it is related. The subject in this case is ‘teaching’ towards which students may have either positive or negative affect.

**Attitude towards Teaching**

According to Miller (1934), one’s attitude towards any profession is a measure of the positive or negative affect he has towards that occupation.

Attitude is an emotional reaction towards a person or thing. It is a personal response to an object, developed through experience, which can be characterised as favourable or unfavourable. The use of ‘teaching’ as the object or stimulus of the feelings delineates a set of attitudes known as ‘attitudes towards teaching’.

**Attitude towards Teaching Mathematics**

Attitude towards teaching mathematics is defined as a generalised attitude towards the universe of teaching of mathematics content and is measured in terms of its favourableness or unfavourableness of the subject.

In the present study, the term ‘attitude towards teaching mathematics’ refers to the reaction of prospective mathematics teachers on various teaching-learning situations or concepts as measured by an attitude scale developed for the purpose.
Prospective Teachers

Prospective teachers include those who are involved in traditional teacher education programmes, those who have graduated from traditional teacher education programs but who are not currently teaching, and those who are interested in becoming teachers but lack the official prerequisite for entry into teaching.

In the present study, students who are studying B.Ed. course in Colleges of Education are considered as prospective teachers.

Prospective Mathematics Teachers

Prospective teachers who have selected mathematics as one of the teaching method subjects in their B.Ed. course are considered as prospective mathematics teachers.

Urban Prospective Mathematics Teachers

Prospective mathematics teachers who have urban residential background are considered as urban prospective mathematics teachers.

Rural Prospective Mathematics Teachers

Prospective mathematics teachers who have rural residential background are considered as rural prospective mathematics teachers.

Graduate Prospective Mathematics Teachers

Prospective mathematics teachers with graduate qualification are included in this group.
Post-Graduate Prospective Mathematics Teachers

Prospective mathematics teachers with post-graduate qualification are included in this group.

Academic Achievement

According to the Dictionary of Education, academic achievement means the knowledge attained or skills developed in the academic subjects usually designated by test scores or marks assigned by the teacher or both.

Academic achievement is the indicator of a teacher’s future success in general and in the field of education in particular.

In the present study, the average of the scores obtained by the student in the board exams of tenth class, intermediate and graduation is considered as the academic achievement of the prospective mathematics teachers.

Community

The word community means a group of people gathered ‘to serve together’. It is a group of social beings leading a common life including O.C. (open category), B.C. (backward caste) and S.C. (scheduled caste), all infinite variety and complexity of relations which result from common life that constitute it.
VARIABLES OF THE STUDY

A variable, as the name implies, is something which varies. This is the simplest and broadest way of defining the term ‘variable’. However, a behaviour scientist attempts to define a variable more precisely and specifically. From his point of view, variables may be defined as those attributes of objects, events, things and beings which can be measured. In other words, variables are the characteristics or conditions that are manipulated, controlled or observed by the experimenter. Aptitude, attitude, adjustment, intelligence, socio-economic status, achievement, etc., are the examples of variables commonly employed in psychology, sociology and education. Variables are necessary requisites for any worthwhile research for the purpose of comparison. After reviewing the literature in the field of teaching effectiveness, teaching aptitude and attitude towards teaching, the following five variables were selected for each of the three areas of the present study.

1. Locality
2. Gender
3. Educational Qualification
4. Academic achievement
5. Community

1. Locality

The rural and urban prospective mathematics teachers may differ in a variety of aspects such as exposure to environment and work, participation in social issues, educational culture, morale, academic affairs,
problem solving approach, co-curricular and extra-curricular activities. These aspects may influence their teaching effectiveness, teaching aptitude and attitude towards teaching. Rural students give more preference to taking admission into teaching programme than urban students and the difference is visible in all Colleges of Education. It is assumed that the rural and urban living brings variations in the level of teaching effectiveness, teaching aptitude and attitude towards teaching of prospective mathematics teachers.

So, a comparison between rural and urban prospective mathematics teachers will reveal any difference that exists in their teaching effectiveness, teaching aptitude and attitude towards teaching.

2. Gender

It is presumed that men and women have different types of attitudes and abilities. Gender differences are studied in majority of the areas of research. Are men and women different? They are different anatomically, but are they different in any other ways? Do their hormonal differences influence their behaviours and attitudes? In a traditional society, men got chances to study and the women were bounded to their kitchens.

But, with the commitment of the government to encourage women in education, the scenario has changed. Women are provided with 33% reservations in admissions in educational institutions in Andhra Pradesh. The traditional view is that women are more interested in teaching so they may possess more teaching effectiveness, teaching aptitude and attitude towards teaching. Whereas men are more interested in problem solving approach, but now, women are also excelling in academics including
mathematics. At the same time, teaching is the most preferred profession to women. There is a need to study this variable to evaluate the present conditions.

So, gender was included in the present study to find out whether there is any significant difference between men and women prospective mathematics teachers in the level of their teaching effectiveness, teaching aptitude and attitude towards teaching.

3. Educational Qualification

The prospective mathematics teachers studying in the Colleges of Education possess varied qualifications. The minimum qualification that is required for joining in B.Ed. course in a College of Education is graduation. Graduates are being treated as one group, namely, graduate prospective mathematics teachers; the prospective teachers possessing post-graduate degree are termed as post-graduate prospective mathematics teachers.

The graduates study mathematics in colleges for three years and the post-graduates study mathematics for five years in colleges and universities. The post-graduates will have different exposure towards the subject knowledge, teaching aptitude and attitude towards teaching mathematics than the graduates and they also differ in age and learning experience. These may cause the differences in their teaching effectiveness.

So, a comparison between graduate and post-graduate prospective mathematics teachers will reveal any difference that exists in the teaching effectiveness, teaching aptitude and attitude towards teaching mathematics.
4. Academic Achievement

Academic Achievement is a major factor for the proper selection of teacher candidates. Academic achievement is one of the criteria for selecting the student teachers for the job as a teacher. The NCTE had stipulated that prospective teacher should have 50% of marks in graduation and/or post graduation to take admission in a College of Education. Teaching is the last option to the majority of graduates and the percentage criterion is restricting some of the graduates to enter into the profession. Moreover, universities are not using any standardised tests for the measurement of achievement of the students at graduation level, instead all that they adopt are only teacher made tests and on many occasions, the valuation of examination papers is also much criticised.

In general, students with above 45% of marks will take admission in the B.Ed. course. Based on the university norms, the total students will be divided into three groups (high academic achievers, average academic achievers and low academic achievers).

Theoretically, it is proposed that there exists a relation between teaching effectiveness, teaching aptitude and attitude towards teaching to a certain level. Educational achievement is also closely associated with one’s level of intelligence. There is a need to examine the impact of the academic achievement on the dependent variables. So, the academic achievement was taken as a variable in the study.

5. Community

The sample of prospective mathematics teachers included in the study was divided into three groups on the basis of their community, viz., the prospective mathematics teachers belonging to forward community
(O.C.), backward community (B.C.), and scheduled community (S.C.). The teaching effectiveness, teaching aptitude and attitude towards teaching mathematics scores will be analysed to see whether there exists any significant difference among these three groups as they belong to different social, economic and cultural settings.

**HYPOTHESES OF THE STUDY**

Hypothesis has a very important place in research. It is almost impossible for a research worker not to have one or more hypotheses before proceeding with the work. It provides direction to research. It places specific goals before the researcher. It serves the function of linking together related facts and information and organising them into one comprehensible whole. It enables the investigator to understand with greater clarity the problem and its ramifications, as well as the data which bear on it. It serves as a framework for drawing conclusions. It makes possible the interpretation of data in the light of tentative proposition or provisional guess. It provides the outline for stating the conclusions in a meaningful way.

Hypothesis is a guess, a supposition or a tentative inference as to the existence of some fact, condition or relationship relative to some phenomenon which serves to explain such facts as already known to exist in a given area of research and to guide the search for the new truth.

Hypothesis may be defined as a proposition or a set of propositions set forth as an explanation for the occurrence of some specified group or phenomena either asserted merely as a provisional conjecture to guide some investigation or accepted as highly probable in the light of established facts.
In the present study, the hypotheses were formulated on the basis of objectives of the study as objectives are the driving force for the formulation of hypotheses. Hypotheses were set up in a null form as this form is akin to the legal principle that a man is innocent until he is proved guilty (Guilford and Fruchter 1978, Garret 1966). According to Best and Kahn (1996, p.27), ‘the null hypothesis relates to a statistical method of interpreting conclusions about population characteristics that are inferred from the variable relationships observed in samples.’

The study formulated Null hypotheses on three dependent variables, namely teaching effectiveness, teaching aptitude and attitude towards teaching mathematics. Each one of the main hypotheses has been studied in further detail by forming sub-hypotheses under each head. Non directional differential form of hypothesis was used to test the statistical significance of the difference between two sub samples. Association hypothesis was used to test the association between two variables.

The following hypotheses were formulated in the present study.

**Hypothesis 1**

Prospective mathematics teachers do not possess high teaching effectiveness.

**Hypothesis 1a**

There is no significant difference in the teaching effectiveness of rural and urban prospective mathematics teachers.
Hypothesis 1b

There is no significant difference in the teaching effectiveness of men and women prospective mathematics teachers.

Hypothesis 1c

There is no significant difference in the teaching effectiveness of graduate and post-graduate prospective mathematics teachers.

Hypothesis 1d

There is no significant difference in the teaching effectiveness of low, average and high academic achievement group prospective mathematics teachers.

Hypothesis 1e

There is no significant difference in the teaching effectiveness of O.C., B.C. and S.C. prospective mathematics teachers.

Hypothesis 2

Prospective mathematics teachers do not possess high teaching aptitude.

Hypothesis 2a

There is no significant difference in the teaching aptitude of rural and urban prospective mathematics teachers.

Hypothesis 2b

There is no significant difference in the teaching aptitude of men and women prospective mathematics teachers.
Hypothesis 2c

There is no significant difference in the teaching aptitude of graduate and post-graduate prospective mathematics teachers.

Hypothesis 2d

There is no significant difference in the teaching aptitude of low, average and high academic achievement group prospective mathematics teachers.

Hypothesis 2e

There is no significant difference in the teaching aptitude of O.C., B.C. and S.C. prospective mathematics teachers.

Hypothesis 3

Prospective mathematics teachers do not possess high attitude towards teaching mathematics.

Hypothesis 3a

There is no significant difference in the attitude towards teaching mathematics of rural and urban prospective mathematics teachers.

Hypothesis 3b

There is no significant difference in the attitude towards teaching mathematics of men and women prospective mathematics teachers.

Hypothesis 3c

There is no significant difference in the attitude towards teaching mathematics of graduate and post-graduate prospective mathematics teachers.
Hypothesis 3d

There is no significant difference in the attitude towards teaching mathematics of low, average and high academic achievement group prospective mathematics teachers.

Hypothesis 3e

There is no significant difference in the attitude towards teaching mathematics of O.C., B.C. and S.C. prospective mathematics teachers.

Hypothesis 4

There is no significant association among teaching effectiveness, teaching aptitude and attitude towards teaching mathematics of prospective mathematics teachers.

Hypothesis 4a

There is no significant difference in the association among teaching effectiveness, teaching aptitude and attitude towards teaching mathematics of rural and urban prospective mathematics teachers.

Hypothesis 4b

There is no significant difference in the association among teaching effectiveness, teaching aptitude and attitude towards teaching mathematics of men and women prospective mathematics teachers.

Hypothesis 4c

There is no significant difference in the association among teaching effectiveness, teaching aptitude and attitude towards teaching mathematics of graduate and post-graduate prospective mathematics teachers.
Hypothesis 4d

There is no significant difference in the association among teaching effectiveness, teaching aptitude and attitude towards teaching mathematics of low, average and high academic achievement group prospective mathematics teachers.

Hypothesis 4e

There is no significant difference in the association among teaching effectiveness, teaching aptitude and attitude towards teaching mathematics of O.C., B.C. and S.C. prospective mathematics teachers.

SAMPLE OF THE STUDY

After finalising the variables of the present study, considerations were given to whether the entire population is to be made the subjects for data collection or a particular group is to be selected as a representative of the whole population. The population here refers to all the prospective mathematics teachers of Acharya Nagarjuna University of Andhra Pradesh.

Of the two procedures, the second one, namely the selection of a group as a representative of the whole population was found to be more convenient and suitable. This technique leads to a considerable saving of time, effort and finance. As the number of prospective mathematics teachers selected is reasonably small, it is possible to obtain accurate and reliable results. As this sampling technique was more advantageous, it was selected for the collection of data.
In any social research, various methods are utilised for selection and drawing of samples. After a detailed study of all these methods and considering the variables selected for the research work, the ‘stratified sampling method’ was found to be most suitable.

In the stratified sampling method, the entire population will be divided into smaller homogeneous groups or strata, and then a sample is selected within each group. Every sampling unit in the population is placed in one of the strata prior to the selection of the sample so that the sum of the strata is identical with the population.

The stratified sampling method has certain merits as a technique of sampling. Auckoff has rightly said that stratified sampling enables the researcher to make a composition of properties of the strata as well as to estimate population characteristics.

In this stratified sampling method, the investigator will have greater control over the selection of the sample when compared with random sampling. In random sampling, although every group has a chance of being selected and included in the sample, there is every possibility, and sometimes it does happen, that certain important groups are left unrepresented. But, in stratified sampling method, no important group is likely to be left out.

Stratified sampling method is the ideal one when comparison between different variables has to be made, for example, if comparison has to be made between rural and urban prospective mathematics teachers, it would be very difficult to select the required number of units through any
other method of sampling. If any other method is used, the problem of bias and prejudice creeps in.

Replacement of units is also possible in the stratified sampling method. Normally, if a particular unit is not accessible for a study, it is difficult to replace it by another, but in this method it is possible. Stephen states that stratification automatically brings about a replacement of persons lost in the sample, by persons of the same stratum, thus partly correcting the bias that would result if there were no replacement of losses. As the entire population is divided into particular strata, it is easy and convenient to replace an inaccessible case by an accessible one.

In the stratified sampling method, much depends on stratification process. The following precautions were taken while stratifying the population: the variables involved in the study were taken note of, care was taken to see that each stratum in the universe was large enough in size so that the selection of items could be done on random basis, the strata formed were definite and clear cut, each stratum was free from the influence of the other, and there was no overlapping.

Before actually selecting the sample, certain fundamental principles were considered to make the sample scientific and clear cut. (Bhaskara Rao, D. 1989).

Firstly, the 'population' was clearly defined. For the present research work, the population includes all the prospective mathematics teachers studying in Colleges of Education affiliated to Acharya Nagarjuna University.
Secondly, decision was made about the units of the sample. A unit of sample may be a house, a family, a group of individuals or a single individual. A good unit should possess the following characteristics.

1. **Clarity**: The unit should be clearly defined in unambiguous terms. This would make the study easy and efficient. For the present research work, a sampling unit is defined as a prospective mathematics teacher studying in any College of Education affiliated to Acharya Nagarjuna University.

2. **Suitability**: A good unit should be well suited to the problem under study. Since the problem is the study of teaching effectiveness, teaching aptitude and attitude towards teaching mathematics of the prospective mathematics teachers, the unit selected should be well suited to the problem.

3. **Accessibility**: The unit selected should be easily accessible to the researcher. If the units selected are difficult to reach and if the researcher fails to make use of them, the study would be vitiated. The selected sampling units, i.e., prospective mathematics teachers, are easily accessible since the researcher being a mathematics teacher educator can approach any College of Education affiliated to Acharya Nagarjuna University.

Thirdly, availability of sample and preparation of the source list are very much essential. This is an important factor that makes representative selection possible. A source list is the list which contains the names of the units of the population from which the sample may be selected. It may exist even before the beginning of the study or it may be prepared fresh by the investigator himself. Without a source list, study through sampling method is not possible. For the present research work, a source list consisting of the names of Colleges of Education affiliated to Acharya Nagarjuna University.
is used. Care was taken to see that the source list was up-to-date and valid and that there was no repetition of names of the Colleges of Education. This source list was found to be relevant and suitable because it included Colleges of Education as the study deals with the teaching effectiveness, teaching aptitude and attitude towards teaching mathematics of the prospective mathematics teachers studying in these Colleges of Education.

Besides considering these principles, it is extremely important to think about the size of the sample to be selected. If the sample is either too small or too large, it will make the study difficult and the results untenable. According to Parten, ‘an optimum sample in the survey is one which fulfils the requirements of effective representatives, reliability and flexibility. The sample should be small enough to avoid intolerable sampling error.’

The size of the sample for the present research work was decided after considering the following factors (Bhaskara Rao, D, 1989).

1. Since an intensive study was planned, a very large number of samples were not selected. In the case of an intensive study, employing a very large number of samples is not very much useful as it involves huge consumption of resources. A smaller sample will be more convenient.

2. The size and selection of the samples are also influenced by the nature of the population. If the population is homogeneous, even a small-sized sample may yield dependable and required results. If the population is heterogeneous, small-sized samples may not be useful. In case of the present study, the heterogeneous universe was split into smaller homogeneous strata and then the samples were selected from these strata. For example, the prospective mathematics teachers were broadly
grouped under men and women, and rural and urban prospective mathematics teachers. A sample was selected from each of these groups.

3. The researcher needs to determine the number of groups to be formed. In case the number of groups proposed is large, the size of the samples shall have to be large so that every group would be of proper size and suit the requirements of the study; in case the number of groups proposed is small, even small-sized samples can fulfill the requirement. In the case of the present study, the population was divided into rural and urban prospective mathematics teachers; men and women prospective mathematics teachers; graduate and post-graduate prospective mathematics teachers; high, average and low academic achievement group prospective mathematics teachers; and O.C., B.C. and S.C. prospective mathematics teachers. Since the number of groups was moderate, a reasonable sample was selected from each of these groups.

4. The practical considerations and accuracy will also play a vital role in determining the size of the sample. Every study is guided by certain practical considerations such as time, resources, accessibility of the data, etc. Generally, it is believed that a large-sized sample is more representative and usually produces accurate results. This, of course, mainly depends upon the technique of sampling used. If the sampling technique is scientific, even small-sized samples can produce dependable and accurate results. While selecting the size of the sample for the present study, practical considerations like the availability of
resources and time were taken into consideration. Care was taken to make the sample selection technique as scientific as possible.

5. The size of the sample is also governed by the size of the tools to be used. In case the tools are short and the questions asked pertain to certain limited factors, a large sample can be selected. In case the tools are large and the questions complicated, the sample should be small in size so that, from administrative point of view, the researcher may not be put to unnecessary troubles. In the present study, as the tools selected belonged to teaching effectiveness, teaching aptitude and attitude towards teaching mathematics, a very large sample was not selected.

6. The sampling method also determines the size of the sample. When random sampling method is used, the samples have to be large. On the other hand, if samples are selected through stratified sampling method, the reliability can be achieved even with the help of small-sized samples.

Taking these factors that influence the size of the sample into consideration, it was decided that an ideal sample would consist of 500 prospective mathematics teachers. This sample is small enough to avoid unnecessary troubles and large enough to avoid intolerable sampling errors.

After deciding about the sampling method, the population selected was divided into different strata. The variables chosen for the study were considered in dividing the population. The sampling design employed here involved not only the stratification of the population but also the random sampling technique to select the samples from within the stratum.

Table 3.1 : The Detailed Sample Frame is given below:

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Variable</th>
<th>Classification</th>
<th>Sample</th>
<th>Total</th>
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</thead>
<tbody>
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<td>Rural</td>
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<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urban</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>Men</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Women</td>
<td>250</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Educational</td>
<td>Graduates</td>
<td>350</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>Qualification</td>
<td>Post-Graduates</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Academic</td>
<td>Low achievement group</td>
<td>94</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td>achievement</td>
<td>Average achievement group</td>
<td>256</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>High achievement group</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Community</td>
<td>O.C.</td>
<td>145</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B.C.</td>
<td>240</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>S.C.</td>
<td>115</td>
<td></td>
</tr>
</tbody>
</table>
TOOLS OF THE STUDY

A research tool plays a major role in any worthwhile research as it is the sole factor in determining the accuracy of data and in arriving at conclusion about the problem or study in hand, which ultimately helps in providing suitable remedial measures for the problem. The selection of the tool is a major task and one should take proper care in this regard.

Out of the 8 variables included in the present study, 5 are independent variables, for which information was gathered directly from the selected sample subjects through a personal data sheet. The remaining 3 dependent variables were measured with suitable instruments. Among these instruments, an attitude scale to measure attitude towards teaching of mathematics, and a rating scale to measure teaching effectiveness were developed by the researcher. Teaching Aptitude Test prepared and standardised by Shamim Karim and Ashok Kumar Dixit was translated and adopted for the purpose of measuring teaching aptitude of prospective mathematics teachers. The different techniques and procedures followed in the development of the research tools are discussed below.

TEACHING EFFECTIVENESS SCALE

Teaching effectiveness scale: A controversy regarding criteria

Effectiveness generally refers to the extent to which somebody achieves his purpose. Relating this to the teacher, it is about doing the right things in the teaching process so that at the end of teaching, the goals and objectives of the teachers can be achieved (Awotua-Efebo, 2004). Research findings have demonstrated that effective teaching leads to good academic performance in courses (Abdulkadir, 2006). Also, parents, practitioners and
policy makers agree that the key to improving education and teaching effectiveness is by placing highly skilled and effective teachers in all class rooms.

On the question of utilising value judgements for studying effectiveness, Robinowitz and Travers (1953) pointed out that ‘there is no way to discover the characteristics which distinguish effective and ineffective teachers unless one had made or prepared to make a value judgement. The effective teacher does not exist pure and serene, available for scientific scrutiny, but is instead of fiction in the mind of men. No teacher is more effective than another except as someone so decides and designates.’ Hence, various approaches as well as techniques came into existence to measure teaching effectiveness. To have a glance of different methods used in the past research on teaching effectiveness, a few studies are referred to below.

Anderson (1954) employed eight different types of criteria of teaching effectiveness on 30 teachers and found that their standing on the eight criteria was correlated moderately. On the basis of the results, the author suggested that the evaluation of teachers was to some extent influenced by the choice of the criterion in general. No adequate basis for validation of teacher evaluation has existed at present.

Johnson, Jr. (1955) reported that there were three primary approaches to measure teaching effectiveness, viz., (1) evaluation of qualities assumed to function in the teaching act (presage variable), (2) appraisal of teaching activity (process variable), and (3) evaluation of pupil’s growth (product variable).
Knox (1956) obtained a composite score of teaching success based on (1) acceptability ratings by principals and superintendents, (2) a short form of Wisconsin adoption of the M-Blank used to obtain principal’s estimate of the teacher’s performance, (3) peer ratings and (4) the judgement of a supervisory official of the state department of public instruction.

Beecher (1961) summarised the different types of criteria of effectiveness and the data-gathering devices employed in Wisconsin studies. The number of studies used in different types of criteria and the devices were as follows: (1) in-service ratings by superintendents – 9, principals – 4, other supervisory officials – 5, teacher educators – 20, departmental personnel in the areas of specialisations – 4, state departmental personnel – 11, and self rating – 11, (2) peer ratings – 6, (3) pupil gain scores – 70, (4) pupil rating – 16, (5) composite of test scores from tests thought to measure teaching effectiveness – 14, (6) practice teaching grades – 13, and (7) combination of some or all of the above criteria -83.

Some researchers have taken pupil gain or pupil growth as a criterion of teacher effectiveness. Burkhart (1969), while reviewing research studies, has shown that there are twenty seven studies which make use of the pupil’s growth as the criterion of effective teaching. But, Cohen and Trent (1973) have shown methodological difficulties inherent in measuring pupil gain. McCall (1952) in his year statewide study of North Carolina, attempted to find measures usable in merit ratings. The criterion of teacher merit was the proven ability to produce educational growth in pupils as measured by a wide variety of tests. Hartley and Hagan (1968) who
compared self-development ratings of students with their evaluations of course work found small relations between the response patterns to the respective scales.

Many problems are identified in developing a criterion, based upon pupil’s growth viz., (a) which pupil’s growth shall be measured? (b) how can effects other than teacher effects be controlled? (c) how shall grade differences be controlled? (d) how shall school effects be controlled? (e) how should the reliability of the teaching effectiveness index be estimated? etc. Similarly, the ratings provided by different agencies on the basis of close observation also have many deficiencies and the methodological observations made by specialists to predict the actual behavior pattern of an effective or ineffective teacher too suffers from many difficulties.

Students’ evaluation of their teachers has been suggested to begin at the Universities of Medieval Europe (Centra, 1993). In the modern era, there has been a tremendous increase in interest regarding student teacher’s rating of instruction and this topic has been the subject of a substantial body of research spanning approximately 70 years (Areola, 1995). Student teacher’s evaluations of teaching effectiveness rating scale has been useful in assessing teaching effectiveness, however, its suitability has been established.

In a practical situation, however, measures of teaching effectiveness lack both validity and reliability to a degree that probably makes them indefensible as indicators of teaching effectiveness. Research has shown that rating scale is a feasible approach to the evaluation of teachers’ effectiveness in educational institutions (Marsh, 1987). Scaling involves a
high degree of operationalisation and allows researchers to measure complex issues (Sarantakos, 2003). Furthermore, it enables researchers to summate values of several variables into one score and this with a relatively high degree of reliability. In general, it offers respondents a choice of picking their answers out of given sets of alternatives, which are established in a very careful but also a systematic way.

**Why is Rating Method Preferred?**

It is clear from the existing literature that the problem of measurement of teaching effectiveness may be approached in a number of ways. One way, with which many studies were carried out, is trying to find out to what extent a teacher possesses the various personal, professional and social qualities which make him a successful teacher. But this alone would not suffice since mere possession of these qualities is no guarantee that a particular teacher is effective in his teaching, one should necessarily study the other factors, too, that go to contribute to teaching effectiveness and this is not an easy task.

Observation of a given number of lessons by a single person or even a team of observers with the help of a rating scale, however perfect this instrument may be, would not ensure accurate measurement. The very presence of the unfamiliar persons (observers) in the classroom would tend to influence the teaching of the teachers concerned and also there is no guarantee that throughout the year their teaching would be of the same standard. It is quite possible that really ineffective teacher may just impress his observers in a few lessons when they are presented to him and may consequently get classified as effective or average and the opposite is also
possible, i.e., effective teachers may get classified as ineffective or average on the basis of a few lessons observed during the course of an investigation.

In view of the practical difficulties anticipated in the adoption of the above mentioned procedures, it was decided that the rating of the subjects on the level of teaching effectiveness achieved by them should be done not on the basis of a few lessons observed by him or even a team of persons that might have been enlisted to assist him, or by considering the pupil growth, but by the methodology lecturer concerned who would be quite familiar with the prospective mathematics teachers over a reasonable period of time.

Apart from the above reason, the most frequent method of measuring teaching effectiveness was the rating (Gage, 1963). A few studies which have employed the rating method are referred to in the following paragraphs.

Domas and Tideman (1970) in their bibliography on teacher competence reported the wide-spread use of rating methods in research on teaching. Druker and Remmers (1950) compared ratings given by alumni 10 years after graduation with campus students on the relative importance of 10 teacher characteristics and found that the rank correlation coefficient ($p = 0.92$) was very high. Remmers (1960) pointed out that if 25 or more students ratings were averaged, they were as reliable as the better educational and mental tests available at present. The above fact is also expressed by Noerrlinger (1987) that the student ratings of their teachers
significantly correlated with the ratings of their principals on more effective and less effective teachers.

In view of the above evidences, the researcher preferred a rating scale to measure the teaching effectiveness of prospective mathematics teachers in the present study.

**Meaning of Rating and Rating Scale**

According to Barr (1961) rating is ‘a term applied to expression of opinion or judgement regarding some situation, object or characteristic. Opinions are usually expressed on a scale of values. Rating techniques are devices by which such judgements may be quantified’.

Horrocks and Schoonover (1968) revealed that ‘rating consists of a judgement made under controlled conditions, of the qualities, traits, or characteristics of a person, place process, thing.’

Good (1973) defined rating as ‘an estimate made according to some systematised procedure, of the degree to which an individual or a thing possesses any given characteristic’.

A rating scale is defined by Wayne (1949) as ‘a device for the systematic recording of observations and judgements on a scale of units or values to be awarded to objects’.

According to Freeman (1962) a rating scale is ‘a means of obtaining the judgements of a number of respondents with reference to a limited number of traits of a given individual’.

A rating scale, according to Tuckman (1972), is ‘a device which can be used by an observer to summarise his judgement of the activity or behaviour that he has observed’.
According to Good (1973), a rating scale is ‘a device used in evaluating products or attitudes or other characteristics of persons rated’.

**Who has to rate the teaching effectiveness of prospective mathematics teachers?**

The review of related literature on teaching effectiveness indicates that teaching effectiveness ratings may be obtained from different sources, viz. supervisors, peers, teachers of teaching practice schools and teacher educator concerned.

In the present study, it was decided that the teaching effectiveness of prospective mathematics teachers may be measured basing upon the ratings of the mathematics teacher educator concerned during the teaching practice programme.

**Preliminary form of Teaching Effectiveness Scale**

The various teaching strategies of prospective mathematics teachers which influence their teaching effectiveness were gathered through reviews of related research. To supplement this list of teaching strategies, 5 mathematics teacher educators and 5 experienced mathematics teachers of high schools were asked to write down some other teaching strategies of teachers which contribute to teaching effectiveness of prospective mathematics teachers. Their responses were sorted out and added to the list of strategies collected from the review of research. All the items were rewritten avoiding ambiguity and overlapping. The preliminary form contained 54 teaching strategies. (Appendix - II).
Final form of the Teaching Effectiveness Scale

The preliminary form of the rating scale was given to 10 mathematics teacher educators and 10 mathematics teachers requesting them to select the most important teaching strategies which influence the prospective mathematics teacher’s teaching effectiveness. They were also instructed to identify the unimportant teaching strategies, i.e., the strategies which are not suitable for contributing to teaching effectiveness. Their responses were tabulated and analysed. On the basis of their responses, 33 teaching strategies were picked up as most important. Thus, the most significant teaching strategies which are suitable to prospective mathematics teachers were identified for the purpose of developing a rating scale to measure the teaching effectiveness of prospective mathematics teachers.

The final form of the rating scale was developed with 33 teaching strategies (Appendix - IV). The scale consists of 33 items measuring eight dimensions of teaching effectiveness, namely: Content (8 items), Clarity in Teaching (7 items), Questioning (4 items), Non verbal communication (3 items), Rapport (3 items), Voice characteristics (3 items), Black board (3 items) and Use of Teaching Aids (2 items).

The response is of Likert format ranging from Very Good (VG), Good (G), Average (A), Below Average (BA), and Needs Improvement (NI) on a rating scale of 5 to 1. The highest possible score on this scale is 165 while the lowest score is 33.
Pilot Study

A pilot study was conducted on a sample of 50 prospective mathematics teachers pursuing their B.Ed. course in a College of Education, namely R.V.R. College of Education, Guntur. The researcher being a mathematics teacher educator in the same college acted as a rater to rate the teaching effectiveness of his student teachers during teaching practice programme. The main intention of the pilot study is to establish the validity and reliability of the teaching effectiveness scale.

Validity of the Scale

Determining the validity evidence for the teaching effectiveness scale was a hard task. In the construction of teaching effectiveness scale for the present study, the items were collected from various sources. The preliminary form of the teaching effectiveness scale was given to many senior teacher educators and experienced mathematics teachers to see that the items cover all the aspects of teaching effectiveness. Therefore, it is believed that the teaching effectiveness scale possesses content validity.

In addition to content validity, the following types of validity were also established for the teaching effectiveness scale.

*Intra-rater consistency of the raters*

Each prospective mathematics teacher was rated by 5 student teachers of the same class (his peers) and his mathematics teacher educator (the researcher) through the rating scale consisting of 33 teaching strategies prepared for the purpose (Appendix III). At the end of the rating scale, an overall teaching effectiveness item was given in which the raters rate the overall teaching effectiveness of the prospective mathematics teachers to see whether the raters have consistency within themselves. Correlation
Coefficient was calculated between the overall rating and the average rating on 33 items of the teaching effective scale for all the 5 student teacher raters and the teacher educator rater. It was found that the correlation coefficient was in the range of 0.43 to 0.87. Therefore, it was concluded that the teaching effectiveness scale possessed intra-rater consistency of the raters.

**Inter-rater consistency**

Another measure of validity that was established for this teaching effectiveness scale was inter-rater consistency. The average of the 5 student teacher’s ratings were considered on one side and the teacher educator rating (researcher’s rating) on other side for the group of 50 prospective mathematics teachers. The Karl Pearson’s product moment correlation coefficient was calculated between these two types of raters and it was found high (r = 0.78). Thus inter-rater consistency of the teaching effectiveness scale was statistically significant and hence, valid.

**Reliability**

The reliability of the teaching effectiveness scale was established, using the test-retest method. After one month, the same teaching effectiveness scale was re-administered to the same sample of 50 prospective mathematics teachers (sample for the pilot study) and Karl Pearson’s product moment correlation coefficient was calculated between the first and the second sets of data. The correlation thus found was 0.87 which was high, which ensured the reliability of the teaching effectiveness scale.

The above teaching effectiveness scale was found suitable for the present study as per the validity and reliability of the tool.
Several teaching aptitude tests are reported to have been developed in India and abroad. The researcher analysed the available aptitude tests, reviewed the literature on test construction and discussed with educational experts with a view to decide (i) whether one of the already available aptitude tests can be used for the purpose of the present study, or (ii) to develop a new aptitude test for his own study. After a prolonged discussion on the reliability and validity of aptitude tests and keeping the quantum of work involved in the construction and standardisation of an aptitude test, the researcher came to the conclusion that the development of a standardised aptitude test should be a project to be taken up by the group of experts in psychology. It is not desirable for a candidate registered for Ph.D. to take up such a stupendous task. As per the advice given by the experts, the researcher selected the following aptitude test for his study.

To measure the teaching aptitude of prospective mathematics teachers a test developed and standardised by Shamim Karim and Ashok Kumar Dixit was adopted in the present study.

In the development of the test, the job psychographic method of Otis and Smith was followed for the purpose of collecting and analysing information on various aspects of teaching profession. This yielded a list of abilities and traits which are considered important in the teaching job. The traits mentioned by Witty (1947), Barr (1948), Menon (1949), Adaval (1952), Prakash and Srivastava (1979), Kumar, Promod and Mutha (1980), Chauhan and Jain (1982), etc., were taken into consideration. The findings of the foreign and Indian researchers were also taken into
consideration, and due attention was paid to the comments of some experienced teachers on the selection of the traits. Finally, fifteen abilities and traits that were essential for the successful teacher were selected for the first experimental draft. These fifteen abilities and traits of teaching profession were rated by a group of twenty five psychologists and educationists, on a five point scale – Highly Agreeable, Agreeable, Indifferent, Disagreeable and Highly Disagreeable. The ratings of the experts were ranked and tabulated and on the basis of their ratings, eight higher ones were selected for the final form of the test. The final form of the test contains eight traits or aspects of an efficient teacher as (i) Cooperative nature, (ii) Considerativeness, (iii) Wide Interest and Scholarly Taste, (iv) Fair-mindedness and Impartiality, (v) Moral character and Discipline, (vi) Optimistic Attitude, (vii) Motivational Aspect and (viii) Dynamic Personality.

**Selection of the Items**

Initially, 200 Likert type items were pooled and were reviewed by 10 judges. After the judges had reviewed the items, 60 items were deleted and 160, retained. This form of test was administered on a sample of 500 undergraduate student teachers of 19 to 30 years of age group belonging to rural as well as urban area of Agra district. On the basis of the item analysis, out of 160 items, only 80 highly scored items have been taken for the final form of the test battery, i.e., 10 items of each trait.
Reliability of the Test

Since reliability is the most essential and significant feature of a test, the Split-half and Test-retest reliabilities have been calculated for the test battery. For calculating the split-half reliability, Guttmen and Spearman-Brown’s Prophecy formula were used and they yielded the coefficients of correlation as 0.851 and 0.913 respectively when this test was administered on a sample of 100 student teachers. These reliability coefficients reveal that the present test battery is highly reliable.

For the test-retest reliability, the present test was administered two times to a sample of 100 student-teachers with a time lapse of two weeks and the coefficient of correlation was found to be 0.894, which signifies the high reliability.

Validity of the Test

The validity of the teaching aptitude test was obtained by computing coefficient of correlation between scores of the test and the assessment of the final examination marks and between the scores of the test and marks obtained through the ratings by their respective teachers and Head of the Department (HOD).

The coefficient of correlation between the test scores on 100 student-teachers and the total marks of theory and practical was 0.625.

The teaching aptitude test was prepared by Shamim Karim and Ashok Kumar Dixit following the usual procedure of test construction. Hence, it is reasonable to assume that the test has validity. However, each of the items and all the items as set were critically examined by some teacher educators, who have assisted in the development of teaching
effectiveness and attitude towards teaching mathematics scales. It was felt by them that all the items were relevant and covered the entire dimension under consideration.

**Adoption of the Aptitude Test**

The instrument was in English and Hindi versions. With the help of Telugu department, R.V.R. College of Education, it was translated into Telugu version. The copies of Telugu version were given to language experts for their comments on translation. Their suggestions were carried out and the final form in Telugu version was prepared. English and Telugu versions of the aptitude test were used for data collection. Both English and Telugu versions of Teaching Aptitude Test were given under the Appendices V and VI.

**Test Administration**

As we all know, teaching aptitude is primarily a student-teacher concern as such there should be coordination between the two and each of them should actively participate as well. The items framed in the test do judge the aptitude a teacher has in his teaching and moreover in what degree. As such to make this test a reliable source of measurement of the same, it is advised that before administering the test, a tester should be careful of the following points.

(i) The place of administration of the test should be such that the testee may work comfortably and without any disturbance.

(ii) The usual setting for the test administration is the class room. But the tester should be careful that the class is not over-crowded.
(iii) The prospective teachers should be properly motivated to take the test. The word ‘test’ should, however, never be used at the time of administration of the test. What is important is to avoid threatening situation which is frequently associated with testing.

(iv) The test administrator should see that each prospective teacher has a pen or pencil with him. He should, however, have a stock of pens or pencils with him so that he may be able to meet any emergency.

**Instructions to the Student Teachers**

Some statements are given in the following pages. Please read them carefully. These statements are followed by three types of responses – Agree, Doubtful and Disagree. If you agree to a given statement then put a tick (√) mark in the box which is given against the statement. Follow the same procedure of responding if you disagree or are doubtful. Your responses will be kept confidential, as such respond without any hesitation.’

**Scoring Procedure**

For the purpose of scoring the test, 3 marks should be given to each ‘Agree’ response, 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 should be added together to form total raw score of the test battery.

**Norms and their Interpretation**

The norms for the present test battery were obtained from a sample of 800 secondary teachers, both men and women in equal number which are given in the following table.
Table 3.2: Norms for Teaching Aptitude Test

<table>
<thead>
<tr>
<th>Raw Score Range</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>226-240</td>
<td>Very high teaching aptitude</td>
</tr>
<tr>
<td>211-255</td>
<td>High teaching aptitude</td>
</tr>
<tr>
<td>196-210</td>
<td>Average teaching aptitude</td>
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<tr>
<td>181-195</td>
<td>Low teaching aptitude</td>
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<td>166-180</td>
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<td>136-150</td>
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<td>121-135</td>
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<td>106-120</td>
<td></td>
</tr>
<tr>
<td>96-105</td>
<td></td>
</tr>
<tr>
<td>81-95</td>
<td></td>
</tr>
<tr>
<td>66-80</td>
<td>Very low teaching aptitude</td>
</tr>
<tr>
<td>51-65</td>
<td></td>
</tr>
</tbody>
</table>

The above tool was found suitable for the present study as per the validity and reliability values.

ATTITUDE TOWARDS TEACHING MATHEMATICS SCALE

A mathematics teacher not only has to be effective in teaching his subject but also should have favourable attitude towards teaching mathematics. The term ‘attitude’ refers to reports of what people think or feel or of the ways in which they intend to act. Since it is important for the prospective mathematics teacher how he thinks or feels about teaching mathematics, it is desirable to study their attitude towards teaching mathematics because it not only affects his own behaviour in the classroom but also of the students. It was, therefore, considered appropriate to develop a suitable and dependable scale to measure the attitude of
prospective teachers towards teaching mathematics. This scale has been specifically developed for prospective mathematics teachers undergoing teacher training for secondary schools.

Before embarking upon a discussion on the development of the attitude scale, it may not be out of place to dwell a little on the meaning and definition of attitude.

An attitude is a behaviour pattern, a dynamic trait, a conditioned response, an implicit response, disposition and mental and neutral state of readiness, an anticipatory set or tendency. Many of the aforesaid terms described the nature of attitude as a mental state of readiness or feeling of an individual towards a certain object.

Thrustone (1948) defined attitude as, ‘the degree of positive or negative effect associated with some psychological object. A psychological object, according to him, may be a person, an institution, a religion, a community, an ideal, a subject, a system, a political party or a minority community’.

Cattell (1950) defined attitude as, ‘a dynamic trait commonly arising from deeper sentiment or innate drive which it seeks to satisfy. It is a readiness to implement a certain course of action in regard to some object’.

Guilford (1954) defined attitude as, ‘a personal disposition common to individuals, but possessed to different degrees, which impels them to react to objects, situations or propositions in ways that can be called favourable or unfavourable’.

Thus it may be said that an attitude is a state of readiness or mental set, which an individual holds in relation to his society towards a psycho-
social object. Hence, if the student is asked whether he likes or dislikes a
certain object or course of action, his endorsement measures the strength of
the attitude. Moreover, two individuals having equal favourable attitude
towards an object or course of action may not act in the same way because
they may arrive at the same level of attitude by entirely different routes.

Since attitude is a psychological construct it cannot be directly
measured and the use of only a single statement or question to assess
attitude will not provide reliable responses. The most common approach is
to use a Likert type survey that requires individuals to decide on their level
of agreement with a number of statements related to the different
components of attitudes. The responses are generally on a three-point or
five-point scale, for example, the sentence ’I enjoy taking mathematics
classes to students’ is related to the affect component and strong agreement
suggests a positive attitude in this component. At the same time the
sentence ‘I am under stress in teaching mathematics’ is related to a
negative attitude, also in the affect component.

For developing the attitude towards teaching of mathematics scale,
the researcher has accepted the definition of ‘teaching’ as a professional
activity. It is a system of actions which induce learning through inter-
personal relationship. Attitude towards teaching mathematics has,
therefore, been operationally defined as a generalised attitude towards the
universe of teaching the content of mathematics and is measured in terms
of its favourableness or unfavourableness estimated from the scores
obtained by the prospective teachers on an attitude scale towards teaching
mathematics.
The researcher before constructing the attitude scale reviewed the literature on construction of attitude scales. There are different techniques for measuring attitudes. Among the different techniques available for the construction of attitude scale, the more commonly used techniques described by Edwards (1957) are: (a) the method of paired comparisons, (b) the method of equal-appearing intervals known as Thurstone’s technique, (c) the method of successive intervals, (d) the method of summated ratings also known as Likert’s technique, (e) scalogram analysis, and (f) the scale discrimination technique. The researcher observed that among the techniques available for attitude scale construction, the two most well known methods of measuring attitudes are: (i) Thurstone’s method of equal appearing intervals (1929) and (ii) Likert’s method of summated ratings (1932).

To measure the attitude of prospective teachers towards the teaching of mathematics, a Likert (1932) type of summated rating technique was employed in the present study. Compared to the Thurstone’s scale, the Likert type scales are fairly easy to construct. Likert type of scales can be constructed in a relatively short time, require no judges, and can be scored rapidly. The results obtained with this type of scale as far as reliability and validity is concerned, are quite comparable to those obtained by Thurstone. The coefficient of correlation between the measures of attitudes obtained by the two methods was as high as 0.92 (Edwards and Kenney, 1946). The construction of the scale was done through several procedural steps.
Preliminary form of Attitude Scale

Bearing in mind the important dimensions of teaching like students, subject matter, teachers, etc., a number of items related to attitude of prospective mathematics teachers towards teaching mathematics were collected from various sources. The item pool thus prepared was placed before 5 selected experienced mathematics teacher educators who were asked to suggest changes, if any, to avoid ambiguity, repetition, etc., among the items. The suggestions made by them were incorporated and 60 statements were selected. Each of the statements was arranged on a three point scale with the following alternatives: Agree (A); Undecided (UD); and Disagree (DA). Thus a preliminary form of the attitude scale was prepared in order to conduct the pilot study.

Pilot form of the Attitude Scale

The pilot form of the attitude scale consists of 60 statements which were collected from various sources and refined with the help of experts. This attitude scale in English was translated into the regional language viz. Telugu with the help of some experienced teacher educators and language experts. The translated version was given to some teacher educators who were well-versed with both English and Telugu for review and suggestions. Their suggestions were incorporated and the attitude scale was given to 4 prospective mathematics teachers to see whether they could understand the statements. Such of those words, the meaning of which was not clear for them, were changed and finally Telugu version was prepared. Both English and Telugu versions were given under Appendices VII and VIII.
Pilot Study

The pilot study was conducted on a sample of 200 prospective mathematics teachers selected by a stratified random sampling procedure from colleges of education belonging to Guntur district in Andhra Pradesh. The pilot form of the attitude scale was administered to the sample of prospective mathematics teachers in their respective Colleges of Education.

Even though the attitude scale is self-administering, the prospective mathematics teachers were explained the purpose of the research, and the way they have to answer the items. They were also assured that the data would be used only for research work and would be kept confidential.

For the purpose of scoring, numerical weights were assigned to each of the 3 categories of responses, from 3 to 1 in the case of positive statements and 1 to 3 in the case of negative statements as suggested by Likert (1932).

<table>
<thead>
<tr>
<th>Type of statement</th>
<th>Agree</th>
<th>Undecided</th>
<th>Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Negative</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Selection of the items for the Final Form

The selection of the items for the final form was based on the results of item analysis which provides validity index for each item. The validity index of an item (i.e., discriminating power) is determined by the extent to which the given item discriminates among examinees who differ sharply in the function (or functions) measured by the test as a whole (Garrett, 2006).
Item Analysis

Item analysis is one of the most crucial steps in the construction of a psychological test. Item analysis is the process of studying each item so that only those items that suit the purpose and rationale of the instrument may be selected for the final test. With the exception of projective techniques, most of the psychological tests are made up of large number of items and in almost all the tests, the test score is always the result of individual’s performance on each of the items of the test. Thus, reliability and validity of a test ultimately rests on the items of the test. It is, therefore, very essential in psychological testing to know how to retain the best items in the test so that they serve the very purpose for which the instrument is prepared. Hence reliability and validity of the test can be best determined through the process of item analysis.

Item analysis of the responses given by the prospective mathematics teachers was carried out by the method of criterion of internal consistency suggested by Likert (1932). This method was used because the results obtained by this procedure agree very well with the results of the traditional method of item analysis and at the same time it is less labourious than the latter, and is advocated by many investigators like Likert (1932), Murphy and Likert (1937), and Edwards (1969). As recommended by Kelly (1939), this method consists of rank ordering the subjects with respect to their total scores and taking the highest scoring 27% and lowest scoring 27% of the sample as criterion groups.

The internal consistency of each of the items was measured by finding their discriminating power. The discriminating power of each item
was calculated by finding the difference between mean scores of the high and low groups on the item. The discriminating power of each of the items thus obtained was tested for significance by applying t-test as suggested by Edwards (1969). An item is valid only when the t-value is significant at least at 0.05 level.

Table 3.4: ‘t’ Values for the Items in the Attitude towards Teaching Mathematics Scale

<table>
<thead>
<tr>
<th>Statement No.</th>
<th>t-value</th>
<th>Statement No.</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.98*</td>
<td>31</td>
<td>0.13</td>
</tr>
<tr>
<td>2</td>
<td>1.76</td>
<td>32</td>
<td>2.59*</td>
</tr>
<tr>
<td>3</td>
<td>2.67*</td>
<td>33</td>
<td>4.32*</td>
</tr>
<tr>
<td>4</td>
<td>2.25*</td>
<td>34</td>
<td>2.29*</td>
</tr>
<tr>
<td>5</td>
<td>2.27*</td>
<td>35</td>
<td>1.02</td>
</tr>
<tr>
<td>6</td>
<td>1.24</td>
<td>36</td>
<td>3.31*</td>
</tr>
<tr>
<td>7</td>
<td>2.28*</td>
<td>37</td>
<td>2.24*</td>
</tr>
<tr>
<td>8</td>
<td>3.48*</td>
<td>38</td>
<td>3.22*</td>
</tr>
<tr>
<td>9</td>
<td>2.87*</td>
<td>39</td>
<td>1.13</td>
</tr>
<tr>
<td>10</td>
<td>1.19</td>
<td>40</td>
<td>2.34*</td>
</tr>
<tr>
<td>11</td>
<td>2.61*</td>
<td>41</td>
<td>3.23*</td>
</tr>
<tr>
<td>12</td>
<td>2.23*</td>
<td>42</td>
<td>3.27*</td>
</tr>
<tr>
<td>13</td>
<td>2.21*</td>
<td>43</td>
<td>0.65</td>
</tr>
<tr>
<td>14</td>
<td>1.12</td>
<td>44</td>
<td>2.24*</td>
</tr>
<tr>
<td>15</td>
<td>3.26*</td>
<td>45</td>
<td>2.34*</td>
</tr>
<tr>
<td>16</td>
<td>3.28*</td>
<td>46</td>
<td>2.26*</td>
</tr>
<tr>
<td>17</td>
<td>2.71*</td>
<td>47</td>
<td>3.36*</td>
</tr>
<tr>
<td>18</td>
<td>2.96*</td>
<td>48</td>
<td>1.08</td>
</tr>
<tr>
<td>19</td>
<td>1.17</td>
<td>49</td>
<td>3.21*</td>
</tr>
<tr>
<td>20</td>
<td>2.79*</td>
<td>50</td>
<td>3.34*</td>
</tr>
<tr>
<td>21</td>
<td>2.26*</td>
<td>51</td>
<td>1.06</td>
</tr>
</tbody>
</table>
Reliability of the Scale

The reliability of the attitude scale was established by the split-half method. The attitude scale was split into two equal halves and the scores on the odd and even numbered items of 200 prospective mathematics teachers were used for computing product moment correlation by using Karl Pearson’s formula. This gave the reliability of the half test. The reliability of the half-test was 0.69. This was corrected for full length of the test by using Spearman Brown Prophecy formula. The reliability of the full test thus obtained was 0.8166.
Validity of the Scale

The problem of validity arises because psychological measurement is indirect. Under such circumstances it is never possible to be certain that the attitude scale does measure the precise characteristics for which it is designed. Thus it is always necessary to gather some sort of evidence which provides confidence that score obtained by the attitude scale really represent what it appears and is intended to represent.

The validity of a measuring instrument can be estimated in various ways. So, there are different types of validity viz., content validity, intrinsic validity, criterion validity, predictive validity, factorial validity, concurrent validity, item validity, and construct validity. But for the present tool, content, criterion, item and intrinsic validities are established.

Content Validity: The choice of an item depends, in the first instance, upon the judgement of competent persons as to its suitability for the purposes of the test. This is the “content validity” as explained by Garrett; H.E. This form of validity is estimated by evaluating the relevance of the test items individually and as a whole.

In the construction of the attitude scale for the present study, the items were collected from various sources. The preliminary form of the attitude scale was given to many senior teachers and teacher educators to see that the items cover all the aspects of teaching. Hence, it may reasonably be assumed that the attitude scale has content validity.

Criterion Validity: At the end of the attitude scale, a specific question was asked: I like teaching mathematics: Yes / No. This statement
is intended to get a direct answer from the prospective mathematics teachers about their attitude towards teaching mathematics.

Among the sample of 200 prospective mathematics teachers only 65 marked ‘No’ to the given statement, while as many as 135 marked ‘Yes’. Out of these 135 prospective mathematics teachers 65 were selected at random. Thus there were two groups of 65 each, one expressing liking towards teaching mathematics while the other indicating a dislike or unfavourable attitude towards it. The mean scores of the two groups were computed and tested the significance of the difference between the means of the two groups by using ‘t’ test.

**Table 3.5 : Means and S.D.’s of Prospective Mathematics Teachers who liked Teaching Mathematics and those who did not like it, and the results of ‘t’ test**

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>Mean</th>
<th>S.D.</th>
<th>t-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liked Teaching</td>
<td>65</td>
<td>96.8</td>
<td>18</td>
<td>3.14 *</td>
</tr>
<tr>
<td>Did not like teaching</td>
<td>65</td>
<td>87.4</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

* Significant at 0.01 level

From the above table it is observed that the mean attitude score of the group who liked teaching was 96.8, while that of those who did not like it was 87.4. The difference between the means of the two groups was significant at 0.01 level. This reveals that those who liked teaching mathematics obtained a significantly higher mean score on the attitude scale than those who did not like teaching mathematics.

Thus it may be concluded that the attitude scale could differentiate successfully those who liked teaching mathematics from those who did not
like it. Therefore, it could be concluded that the attitude scale has criterion validity.

**Item Validity**: There are numerous procedures in which the item validity can be determined. One of these procedures stresses the number of discriminations of the desired sort that the item is capable of making. The discriminating power of each item was estimated and was also tested for significance using t-test, before including them in the final form. Thus, each item of the attitude scale was valid, which ensured the validity of the attitude scale itself.

**Intrinsic Validity**: Guilford (1954) defines ‘intrinsic validity as the degree to which a test measures, what it purports to measure.’ This can also be stated in terms of how well the obtained scores measure the test’s true score components. This validity is given by the square root of the reliability of the test. The intrinsic validity of the scale was 0.904. (Square root of 0.8166).

The above attitude scale was found suitable for the present study as per the validity and reliability values.

**PERSONAL DATA SHEET**

The information with regard to the different independent variables included in the study, viz. locality, gender, educational qualification, academic achievement and community of the prospective mathematics teachers were obtained from them through a carefully designed personal data sheet. The English version of the personal data sheet is given in the Appendix I.
ADMINISTRATION OF THE TOOLS

For obtaining teaching effectiveness of the sample of prospective mathematics teachers selected for the study, the mathematics teacher educators of the sample Colleges of Education were requested to act as raters. The researcher visited all the colleges of education included in the study and a good rapport was developed with the mathematics teacher educators. The teaching effectiveness scale meant for the rater was given with a request to rate the teaching effectiveness of the sample of prospective mathematics teachers selected for the study in his or her College of Education. The procedure of rating was explained to make him or her understand clearly what he or she should do. Thus, the data about the teaching effectiveness of the total sample of prospective mathematics teachers was collected through mathematics teacher educators.

The prospective mathematics teachers, who were rated by their mathematics teacher educator, were given the booklet of research tools meant for them, viz. personal data sheet, teaching aptitude test and attitude towards teaching mathematics scale and requested them to respond to all parts of the booklet of research tools and to all statements without leaving any part or any statement. For the data collection, the researcher took the help of mathematics teacher educators concerned and administered the tests after taking the prior permission from the principal of the college. Before administering the tools, clear instructions were given to the prospective mathematics teachers and their doubts were clarified. Tools were administered in ideal conditions.
Thus, the data with regard to the independent variables included in the study, viz. residential locality, gender, educational qualification, academic achievement and community and also the teaching aptitude and the attitude towards teaching mathematics of the total sample of prospective mathematics teachers were collected through the administration of the tools on the selected sample.

**SCORING PROCEDURE**

For every statement in the teaching effectiveness scale, the weights 5, 4, 3, 2 and 1 were given to the five alternatives Very Good (VG), Good (G), Average (A), Below Average (BA) and Needs Improvement (NI) respectively. The grand total of the teaching effectiveness scale was obtained by adding the scores on all the 54 statements. A composite teaching effectiveness index for each prospective mathematics teacher was obtained by taking the average of the teaching effectiveness scores secured by the prospective mathematics teachers in 3 lessons taught by them during teaching practice programme.

For every item in the teaching aptitude test, the weights 3, 2 and 1 were given to the three alternatives Agree (A), Undecided (UD) and Disagree (DA) respectively. The grand total of the teaching aptitude test was obtained by adding the scores on all the 80 statements.

Attitude towards teaching mathematics scale was scored on a three-point scale by giving weights 3 to 1 in the case of positive statements and 1 to 3 in the case of negative statements to the three alternatives, viz. Agree, Undecided and Disagree respectively. The grand total on the scale was obtained by adding the weights on all the 40 statements.