CHAPTER – III

METHODOLOGY OF RESEARCH
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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 analyzing 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.

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.

In normative survey method, the term ‘normative’ implies 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 organized attempt to analyze, 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.

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 characterized by flexible, appropriate, efficient, economical procedure to conduct the study. Generally the design, which minimizes bias and maximizes 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.

**OPERATIONAL DEFINITIONS OF KEY TERMS**

The operational definitions of the important terms used in the present study are discussed here.

**Creativity**

Creativity is judged on the basis of the verbal creativity scores obtained on all the components of creativity, namely: Fluency, Flexibility and Originality.
• Fluency is the ability to produce many ideas for a given task.

• Flexibility is the ability to produce ideas that show a person's movement from one level of thinking to another or shifts in thinking.

• Originality is the ability to produce ideas that not many people think of or that are unusual, remote and clever.

Scientific Attitude

The components of scientific attitude identified to study are Rationality, Curiosity, Open Mindedness, Aversion to Superstitions, Objectivity in Intellectual Honesty and Suspended Judgment.

Attitude towards Science

Attitude towards science is defined as a generalized attitude towards the universe of science content and measured in terms of its favorableness or unfavourableness of the subject.

Prospective Science Teacher

Students who are studying B.Ed. program with the methodology of science (both biological and physical sciences) in Colleges of Education were considered as prospective science teachers.

Urban Prospective Science Teachers

Prospective science teachers belonging to urban areas were considered as urban prospective science teachers.

Rural Prospective Science Teachers

Prospective science teachers belonging to rural areas were considered as rural prospective science teachers.
Telugu Medium Prospective Science Teachers

Prospective science teachers who studied at Telugu medium at degree level were considered as Telugu medium prospective science teachers.

English Medium Prospective Science Teachers

Prospective science teachers who studied in English medium at degree level were considered as English medium prospective science teachers.

Graduate Prospective Science Teachers

Prospective science teachers with graduate qualification were included in this group.

Post-Graduate Prospective Science Teachers

Prospective science teachers with post-graduate qualification were included in this group.

Below Poverty Line Families

Below poverty line is an economic benchmark and poverty threshold used by the government of Andhra Pradesh to indicate economic disadvantage and to identify individuals and households in need of government assistance and aid. The income limit for a below poverty line (BPL) family is Rs 60000 in rural areas and Rs 75000 in urban areas. Prospective science teachers belong to BPL families were included in this group.

Above Poverty Line Families

The family income above the limit of below poverty line (BPL) is classified under above poverty line (APL) family. Prospective science teachers belong to APL families were included in this group.
VARIABLES OF THE STUDY

A variable, as the name implies, is something which varies. This is the simplest and broadest way of defining a 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 characters or conditions that are manipulated, controlled or observed by the experimenter. Intelligence, anxiety, aptitude, adjustment, satisfaction income, education, authoritarianism, achievements, 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 creativity, scientific attitude and attitude towards science, the following six variables were selected for each of the three areas of the present study.

1. Locality
2. Gender
3. Educational Qualifications
4. Medium of Instruction at Graduation
5. Academic Achievement at Graduation
6. Annual Income of the Family

1. Locality

The rural and urban prospective science teachers differ in a variety of aspects such as exposure to environment and work, participation in social
problems, educational culture, morale, academic affairs, co-curricular and extra-curricular activities. These will definitely influence creativity, scientific attitude and attitude towards science. Rural students will give more preference to take admission into teaching program than urban students. The difference is visible in all Colleges of Education. It is found that more rural students than urban students are pursuing the teacher education programs. So, a comparison between rural and urban prospective science teachers will reveal if any difference exists in their creativity, scientific attitude and attitude towards science.

2. Gender

Gender differences are studied in majority of the areas of research. Are men and women different? They're different anatomically, but are they different in any other ways? Do their hormonal differences influence their behaviors and attitudes? Do they process information differently? In a traditional society men were getting 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% reservation in educational institutions in Andhra Pradesh. The traditional view is that women are less scientific and their attitude towards science is lower than men. But, now, women are also excelling in academics, including science subjects. At the same time, teaching is the most preferred profession to the women. There is a need to study this variable to evaluate the present
conditions. So, a comparison between men and women prospective science teachers will reveal any difference that exists in their creativity, scientific attitude and attitude towards science.

3. Educational Qualifications

In general, prospective science teachers are found with two types of qualifications (Graduation with and Post-Graduation). The graduates study science in colleges for three years and the post-graduates study science for five years in colleges and universities.

The post-graduates will have different exposure towards the subject knowledge, creative environment than the graduates and they also differ in age. These may cause the differences in their behaviour. So, a comparison between graduate and post-graduate prospective science teachers will reveal any difference that exists in the creativity, scientific attitude and attitude towards science.

4. Medium of Instruction at Graduation

The medium of instruction has a critical role in teaching and learning as it is the channel for proper communication. The communication skills and language efficiency will play their legitimate role in inculcating creativity, scientific attitude and attitude towards science. Instruction in local language will help the student to learn effectively and the instruction in English will help the students to get good exposure and access to a pool of resources to enrich the knowledge of science. There is a need to examine the difference between...
prospective science teachers and their language backgrounds, to know the impact. Hence, this variable was considered for the study.

5. Academic Achievement at Graduation

Academic achievement is the criteria for selecting the students for admission into B.Ed program, and also for the job as a teacher. NCTE had stipulated that prospective student should have 50% in graduation and/or post graduation to take admission. Teaching is the last option to the majority of graduates and the percentage criteria is restricting some of the graduates to enter into the profession. Moreover universities are not using any standardized tests for the measurement of achievement of the students at graduation level, instead all that they adopt are only teacher made tests.

In general, students with 45% to 75% and above will take admission in the B.Ed. 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 intelligence and creativity 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 as a variable is included in the study.

6. Annual Income

Exposure to better life and learning environment depends on the family income of the prospective science teachers. In the present technological era,
the ability of a student will be adversely affected by the lack of access to the resources which in turn is determined by the income level. Internationally, an income of less than $1.25 per day at 2005 international prices per head of purchasing power parity is defined as extreme poverty. By this estimate, about 40% of Indians are extremely poor. The government of Andhra Pradesh is following the policy of identifying every household with annual income up to Rs 60,000 in rural area and Rs. 75,000 in urban areas as a BPL family. As such, there is a need to examine the income levels of the prospective science teachers’ families and its impact on the level of creativity, scientific attitude and attitude towards science. The study intends to see the impact of annual income on the dependent variables.

HYPOTHESES OF THE STUDY

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.

A 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.

The study formulated Null hypotheses on three dependent variables, namely; creativity, scientific attitude and attitude towards science. Each one of
the main hypotheses has been studied in further detail by forming six sub-
hypotheses under each head.

**Hypothesis 1**

Prospective science teachers are not possessing high creativity.

**Hypothesis 1a**

There is no significant difference in the creativity of rural and urban prospective science teachers.

**Hypothesis 1b**

There is no significant difference in the creativity of male and female prospective science teachers.

**Hypothesis 1c**

There is no significant difference in the creativity of graduate and post-
graduate prospective science teachers.

**Hypothesis 1d**

There is no significant difference in the creativity of Telugu medium and English medium prospective science teachers.

**Hypothesis 1e**

There is no significant difference in the creativity of high, average and low academic achieving prospective science teachers.

**Hypothesis 1f**

There is no significant difference in the creativity of prospective science teachers of below poverty line and above poverty line families.
Hypothesis 2

Prospective science teachers are not possessing high scientific attitude.

Hypothesis 2a

There is no significant difference in the scientific attitude of rural and urban prospective science teachers.

Hypothesis 2b

There is no significant difference in the scientific attitude of male and female prospective science teachers.

Hypothesis 2c

There is no significant difference in the scientific attitude of graduate and post-graduate prospective science teachers.

Hypothesis 2d

There is no significant difference in the scientific attitude of Telugu medium and English medium prospective science teachers.

Hypothesis 2e

There is no significant difference in the scientific attitude of high, average and low academic achieving prospective science teachers.

Hypothesis 2f

There is no significant difference in the scientific attitude of prospective science teachers of below poverty line and above poverty line families.

Hypothesis 3

Prospective science teachers are not possessing high attitude towards science.
Hypothesis 3a

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

Hypothesis 3b

There is no significant difference in the attitude towards science of male and female prospective science teachers.

Hypothesis 3c

There is no significant difference in the attitude towards science of graduate and post-graduate prospective science teachers.

Hypothesis 3d

There is no significant difference in the attitude towards science of Telugu medium and English medium prospective science teachers.

Hypothesis 3e

There is no significant difference in the attitude towards science of high, average and low academic achieving prospective science teachers.

Hypothesis 3f

There is no significant difference in the attitude towards science of prospective science teachers of below poverty line and above poverty line families.

Hypothesis 4

There is no significant association among creativity, scientific attitude and attitude towards science of prospective science teachers.
Hypothesis 4a

There is no significant difference in the association among creativity, scientific attitude and attitude towards science of rural and urban prospective science teachers.

Hypothesis 4b

There is no significant difference in the association among creativity, scientific attitude and attitude towards science of male and female prospective science teachers.

Hypothesis 4c

There is no significant difference in the association among creativity, scientific attitude and attitude towards science of graduate and post-graduate prospective science teachers.

Hypothesis 4d

There is no significant difference in the association among creativity, scientific attitude and attitude towards science of Telugu medium and English medium prospective science teachers.

Hypothesis 4e

There is no significant difference in the association among creativity, scientific attitude and attitude towards science of high, average and low academic achieving prospective science teachers.
Hypothesis 4f

There is no significant difference in the association among creativity, scientific attitude and attitude towards science of prospective science teachers of below poverty line and above poverty line families.

SAMPLE OF THE STUDY

After finalizing 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 entire population here refers to all the prospective science teachers 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 science teachers selected is 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 utilized 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.

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 science 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 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 selection of items could be done on random basis; the strata formed were definite and clear cut; each stratum was free from 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, 1989)

Firstly, the 'universe' was clearly defined. In the technical phraseology of research, the whole population out of which the samples are selected is known as the 'universe'. For the present research work, the universe includes all the prospective science teachers studying in Colleges of Education of Andhra Pradesh.

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 science teacher studying in any College of Education in Andhra Pradesh.
Pradesh. 2. Suitability: A good unit should be well suited to the problem under study. Since the problem is the study of the creativity, scientific attitude and attitude towards science prospective science teachers, the unit selected is 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 science teachers, are easily accessible since they could be approached in any College of Education.

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 universe from which the sample may be selected. It may exist even before the beginning of the project or it may be prepared afresh 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 in Anantapuram and Chittor districts of Andhra Pradesh 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 creativity, scientific attitude and attitude towards science prospective science teachers.

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 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 sample for the present research work was decided after considering the following factors. (Bhaskara Rao, 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 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 universe. If the universe is homogeneous, even a small-sized sample may yield dependable and required results. If the universe is heterogeneous, small-sized samples may not be useful. In the 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 science teachers were broadly grouped under male and female, and rural and urban prospective science 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 universe was divided into Telugu medium and English medium prospective science teachers; graduate and post-graduate science teachers; prospective science teachers of high academic achievement, average academic achievement and low academic achievement; and prospective science teachers of above poverty line and below poverty line families. Since the number of groups was moderate, a reasonable sample was selected from each of these groups.

4. 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 creativity and
scientific attitude and attitude towards science, 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 800 prospective science 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 universe selected was divided into different strata. The variables chosen for the study were considered in dividing the universe. The sampling design employed here involved not only the stratification of the universe but also the random sampling technique to select the samples from within the stratum.

The total sample of 800 prospective school science teachers consisted of urban prospective science teachers-352; rural prospective science teachers-448; male prospective science teachers-372; women prospective science teachers-428; graduate prospective science teachers-652; post-graduate prospective science teachers-148; English medium prospective science teachers-216; Telugu medium prospective science teachers-584; high-240, average-456 and low-104 academic achievement groups, and high-344, above middle-92, middle-128 and low group-236. prospective science teachers of below poverty
line families 456; prospective science teachers of above poverty line families 344.

Table-3.1: Showing the sample size in the present study

<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>
<tr>
<td>1</td>
<td>Locality</td>
<td>Rural</td>
<td>448</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Urban</td>
<td>352</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>Male</td>
<td>372</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>428</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Education Qualifications</td>
<td>Graduates</td>
<td>652</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Post-Graduates</td>
<td>148</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Medium</td>
<td>Telugu Medium</td>
<td>584</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>English Medium</td>
<td>216</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Academic Achievement</td>
<td>High</td>
<td>240</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Average</td>
<td>456</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Annual Income</td>
<td>BPL</td>
<td>456</td>
<td>800</td>
</tr>
<tr>
<td></td>
<td></td>
<td>APL</td>
<td>344</td>
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</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. Selection of the tool is a major task and one should take adequate care in this regard.

The selection and use of the tools can be done in two ways. The first one is to construct a tool independently by the investigator for his own study. Here, there are many problems in doing so. Preparation and standardization of a perfect tool itself is a major task and one can safely say that it is a doctoral study. On construction of their own tools, Anand and Padma (1987) felt that "A note of caution has to be struck when a researcher develops a tool for his study by merely pooling some items and does not subject it to the sophisticated techniques of tool construction. The result would be then, obviously, a poor quality research". With this, one can say that preparation and standardization of tools is a major task, and one should take care of aspects like selection of area and sample, pooling up of statements related to the area, consulting the experts and application of sophisticated statistical techniques. (Bhaskara Rao, 1997)

The other way of selection and use of tools is right selection of tools from already standardized ones available in the field of study. Here again locating the tools and identifying their usefulness to the study on hand is a tedious job. Even then, this technique is very useful when a research work is studied in depth, when the research work involves a good number of variables and when
there is scarcity of time and other resources. Some people believe that some of the instruments available do not measure up to their standards. In some instances, consideration should be given to the logistics of the situation. Lacking time and financial resources for the construction of a test, many researchers can not expect to produce a better instrument. In these cases, the most logical procedure that one can follow is to choose the best instrument available for this purpose. (Bhaskara Rao, 1997)

**MEASUREMENT OF CREATIVITY**

Considering the flaws and merits of the selection of tools in either way, the researcher is interested in using the standardized tool as the present study involves a thorough study of creativity of the prospective science teachers. Hence, the investigator selected the "Verbal Test of Creative Thinking", which was prepared and standardized by Baqer Mehdi, to study the creative ability of prospective science teachers studying in colleges of education in Andhra Pradesh.

**Details of VTCT**

The battery is meant to identify creative talent at all stages of education, expect pre-primary and primary. The type of tasks included in the test have been chosen so that they could be most easily and economically administered over a wide age range of sample starting from middle school and going up to the graduate level.

The verbal test of creativity includes four sub tests, namely consequences test, unusual test, similarity test and product improvement test.
(i) **Consequences test:** The consequences test consists of three hypothetical situations: (a) What would happen if man could fly like birds? (b) What would happen if our schools had wheels? And (c) What would happen if man does not have any need for food? The subject is required to think as many consequences of these situations as he can, and write them under each situation in the space provided. The situations being hypothetical, minimize the effect of experience and also provide the subject with an unlimited opportunity to make responses. The test encourages free play of imagination and originality. The time allowed for the three problems is 4 minutes each.

(ii) **Unusual uses test:** This test presents the subject with the names of three common objects- a piece of stone, a wooden stick and water and requires him to write as many novel, interesting and unusual uses of these objects as he may think of. This test measures the subject’s ability to retrieve items of information from his personal information in storage. Evidently it measures also the subject’s ability to shift frames of reference to use the environment in an original manner. The time allowed for the three tasks is 5 minutes each.

(iii) **New relationships test:** This test presents the subject with three pairs of words apparently different-tree and house, chair and ladder, air and water and requires him to think and write as many novel
relationships as possible between the two objects of each pair in the space provided. The test provides an opportunity for the free play of imagination and originality. The time allowed for each pair of words is 5 minutes.

(iv) Product improvement test: In this test, the subject is asked to think of a simple wooden toy of a horse and suggest addition of new things to it to make it more interesting for the children to play. The time allowed is 6 minutes.

The total time required for administering the test is 48 minutes in addition to the time necessary for giving instructions, passing out test booklets to children and collecting them back.

Selection of the Items

The basis of consequences activity is Guilford’s Consequences Test or Torrance’s Just Suppose Activity. The tasks included in this activity are based on familiar things but are presented in the form of a hypothetical situation. The tasks confront the subject with a situation which he can think of with a large number of possibilities to hypothetical happening. This implies cause and effect thinking. The event is mentioned and the subject has to think of the consequences that may occur as a result of that stimulus, event, or happening, whether the happening is usual or unusual, logical or illogical. Thus the number of relevant responses produced by the subject yields a measure of his ideational fluency, the number of shifts in the thinking trends of the consequences gives the measure of verbal flexibility, and the statistical infrequency of the response
of the departure in thinking from the commonplace gives the measure of originality.

The basic idea of unusual uses tasks comes from Guilford’s Brick Uses Test or Torrance’s Tin Can Uses Test, or Cardboard Boxes Uses Test. Common things like water, a wooden stick and a piece of stone are used as stimuli to let the subject’s thinking go in different directions. The Activity appears playful to the child but quickly puts him on a train of thought which will yield many many novel responses. The number of relevant responses may give the measure of one’s ideational fluency, the number of thought categories, the measure of verbal flexibility, and uncommonness of responses, the measure of originality.

Mednick worked extensively with word associations, and his definition of creativity is based upon remoteness of such associations. In new relationships activity, articles of daily use with which the child is quite familiar are taken so as to enable his to think more naturally about relationships between two apparently dissimilar objects. The items of this activity provide possibilities for scoring responses for fluency, flexibility, and originality in the same fashion as for Unusual Uses Test.

Product Improvement test of verbal imagination is similar to the one found in Torrance’s Product Improvement Activity. Torrance used a picture of a toy monkey, but in this test the subject is only asked to imagine a figure of horse toy and then give responses which would indicate that he will do to make it more interesting and unusual for the child to pay with. The task takes the
child to the world of imagination and spurs him to think in different directions. Apart from ideational fluency, the test also measures flexibility and originality.

**Scoring Procedure**

Each item is to be scored for fluency, flexibility and originality.

Fluency is represented by the number of relevant and unrepeated ideas which the testee produces. Relevance is judged on the basis of the appropriateness of the response when considered in relation to the test problem. An unrepeated idea is one which has been expressed only once under a given problem.

Flexibility is represented by a person’s ability to produce ideas which differ in approach or thought trend. All ideas which fall under one category or approach or thought trend are treated as one for the purposes of flexibility scoring. Thus, if five ideas are produced and all belong to only one category of approach or thought trend, then the score for flexibility score will be one but if all the five ideas are based on five different approaches or thought trends, then the flexibility score will be five. There could be intermediate scores for flexibility depending on the number of categories of thought trends to which the responses belong.

Originality is represented by uncommonness of a given response. Responses given by less than 5% of the group are treated as original. The scores may be directly entered on the answer sheet by closely following the scoring guide. If the scorer comes across responses which are not mentioned in the scoring guide, he should briefly mention then on the backside of the scoring
sheet and score then for originality after all the test scripts have been scored. The instructions for scoring the new responses for originality are also given on the scoring sheet.

The raw scores should be converted into standard scores to get the composite creativity.

**Reliability of the test**

The test, retest reliability of the factor scores and also the total score were obtained on a small sample (N=31).

<table>
<thead>
<tr>
<th>Fluency</th>
<th>Flexibility</th>
<th>Originality</th>
<th>Total creativity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.945</td>
<td>0.921</td>
<td>0.896</td>
<td>0.959</td>
</tr>
</tbody>
</table>

As seen, both the factor score and the total creativity score reliabilities are considerably high ranging from 0.896 to 0.959. These values are highly satisfactory. The reliability score which came out to be 0.959 is again quite high. Inter scorer reliabilities for the factor scores in one study were found to range from 0.653 to 0.981.

**Validity of the Test**

The validity coefficients against the teacher ratings for each factor are given in the below given table.
The validity coefficients for factor scores and the total creativity score are high enough to place confidence in the use of the test. Higher correlations with teacher ratings are usually not obtained due to the unreliability of the ratings.

**Relevance for the Present Study**

The English version of the creative thinking test (3 factors) developed by Baqer Mehid is adopted and the test items are translated in to the regional language to get the right response from the sample group of the selected area and supplied to the science teachers, teacher educators and psychologists to see the verbatim and difficulty level. The modifications suggested by the experts are carried out for the final version of the test.

The reliability of the creative test was established by using test-retest method. The researcher has selected 200 prospective science teachers and administered the creativity test to them. Again after one month the same test was given to the same prospective science teachers and test was administered. Then reliability and validity was found to be 0.73 and 0.85. This value shows that this scale is suitable for our condition. The same scale is translated in to Telugu by the researcher with the help of research supervisor.
MEASUREMENT OF SCIENTIFIC ATTITUDE SCALE

After the detailed review of related literature, the investigator identified five tools developed in India to measure scientific attitude. The tool developed by Venkatarami Reddy with 63 items, Vidya Sagar with 48 items, S.C.Gakhar and Amandeep kaur with 61 items, Shailaja Bhagwat with 24 items and J.K.Sood and R.P.Sandhya with 36 items was adopted. After reviewing the available tests of scientific attitude, with the guidance of research supervisor, the scientific attitude scale developed by J.K.Sood and R.P.Sandhya was adopted.

Details of Scientific Attitude Scale

The SAS consists of various dimensions of scientific attitude

Dimension 1: Rationality

- Commitment of the value of rationality
- Tendency to test traditional beliefs
- Seeking for natural cause of events and identification of cause and effect relationship
- Acceptance of criticalness
- Challenge of authority

Dimension-2: Curiosity

- Desire for understanding new situations that are not explained by the existing body of knowledge
- Seeking to find out the why and how of observed phenomena
- Giving emphasis on the question in approach for novel situation
• Desire for completeness of knowledge

Dimension-3: Open mindedness

• Willingness to revise opinions and conclusions
• Desire for new things and ideas
• Rejection of singular and rigid approach to people, things and ideas

Dimension-4: Aversion to superstitions

• Rejection of superstitions and false beliefs
• Acceptance of scientific facts and explanation

Dimension- 5: Objectivity of Intellectual Beliefs

• Demonstration of the greatest possible concern for observing and recording facts without any influence of personal pride, bias or ambition
• Not allowing any change in interpreting results on the basis of present social, economic or political influences

Dimension – 6: Suspended Judgment

• Unwillingness to draw inferences before evidence is collected
• Unwillingness to accept facts that are not supported by the convincing proof
• Avoidance of quick judgment

This scientific attitude scale was constructed by following the Likert method considering its advantages over other methods. This scale was prepared based on the contributions made by J.J. Schwab, J.S.Bruner, Bertand Russel, William D. Romey, P.L.Gordner, Vicotr Y. Billech, Paul B.Diederich Curtis, Noll, Haney E.Richard, etc.
Item Writing, Editing and Revision

An initial pool of 130 statements was prepared. This pool of statements was given to 10 experienced and qualified educators, after getting its language pruned by experts. The experts were requested to rate each statement on three categories by answering the under mentioned questions.

Is the attitude measured by this item?
- essential
- useful but not essential
- not necessary

After collecting the experts opinions on every statement, content validity ratios (C.VR.) were calculated. Statements whose CVRs were more than or equal to 0.62 was significant at 0.05 level of significance for N=10. in this way, the content validity of statements was ascertained quantitatively by utilizing Laushe’s (1975) suggestion. Thus out of 130 statements, only 66 were retained for initial tryout.

Initial tryout

After calculating the content validity ratios of 130 prepared statements, sixty six statements were retained for the initial tryout.

Sixty six statements of different dimensions of scientific attitude were arranged in Likert Method. Fifty percent items were of positive polarity and remaining fifty percent were of negative polarity. This instrument was administered on the sample and was asked to assign any one of the five following categories after reading each statement carefully.
After administration of the instrument, it was scored by considering the scoring procedure suggested by Likert.

For:

<table>
<thead>
<tr>
<th>Response</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA</td>
<td>5</td>
</tr>
<tr>
<td>A</td>
<td>4</td>
</tr>
<tr>
<td>N</td>
<td>3</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
</tr>
<tr>
<td>SD</td>
<td>1</td>
</tr>
</tbody>
</table>

For items of negative polarity, the scoring system was reversed. The t values for 66 statements were calculated to construct a final Scientific Attitude Scale.

**Final form of the scale**

The final form of the scientific attitude scale contained 36 statements of which 18 are positive polarity and 18 are of negative polarity.
The distribution of items is as follows:

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Negative Polarity</th>
<th>Positive Polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rationality</td>
<td>1,2,6</td>
<td>3,4,5</td>
</tr>
<tr>
<td>Curiosity</td>
<td>8,9</td>
<td>7,10,11,12</td>
</tr>
<tr>
<td>Open mindedness</td>
<td>13,14</td>
<td>15,16,17,18</td>
</tr>
<tr>
<td>Aversion to superstitions</td>
<td>19,21,24</td>
<td>20,22,23</td>
</tr>
<tr>
<td>Objectivity of intellectual beliefs</td>
<td>25,26,28,30</td>
<td>27,29</td>
</tr>
<tr>
<td>Suspended Judgment</td>
<td>31,32,34,35</td>
<td>33,36</td>
</tr>
</tbody>
</table>

Each of the eighteen positive items of the scale is assigned a weight ranging from 5 to 1. In the case of eighteen negative items, the scale scoring is reversed ranging from 1 to 5. The attitude score of a subject is the sum total of scores on all the thirty six items of the scale. For each student, a total score on the scale can be obtained by summing his scores for the individual items. Thus a maximum of 180 scores can be obtained by a subject.

**Internal Consistencies and Discriminate Validity**

The reliability of scientific attitude scale score as calculated by split half method is found to be 0.88. Scientific attitude scale is administered on a sample of 200 and this analysis provided information about the internal consistency and discriminant validity of the six dimensions of the scale.

The results are summarized in the following table.
<table>
<thead>
<tr>
<th>Dimension</th>
<th>No of Items</th>
<th>Reliability</th>
<th>Internal Correlation Co- Efficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>Rationality</td>
<td>6</td>
<td>0.76</td>
<td>1.0</td>
</tr>
<tr>
<td>Curiosity</td>
<td>6</td>
<td>0.86</td>
<td>0.35</td>
</tr>
<tr>
<td>Open mindedness</td>
<td>6</td>
<td>0.84</td>
<td>0.31</td>
</tr>
<tr>
<td>Aversion to superstitions</td>
<td>6</td>
<td>0.8</td>
<td>0.34</td>
</tr>
<tr>
<td>Objectivity of intellectual beliefs</td>
<td>6</td>
<td>0.73</td>
<td>0.33</td>
</tr>
<tr>
<td>Suspended Judgment</td>
<td>6</td>
<td>0.82</td>
<td>0.32</td>
</tr>
<tr>
<td>Scientific attitude scale</td>
<td>36</td>
<td>0.86</td>
<td>0.62</td>
</tr>
</tbody>
</table>

Reliability coefficients for six dimensions of scientific attitude scale are found high and these high coefficients are reflecting the strength of each dimension for measuring the scientific attitude. In addition to this, the correlation coefficients between the total scientific attitude score and various dimensions in the scale also high. From the above table it is evident that the correlation coefficients are found to be 0.62, 0.76, 0.80, 0.81, 0.85 and 0.82.

**Relevance for the Present Study**

The reliability of the scientific attitude scale was established by using test-retest method. The researcher has selected 200 prospective science teachers and administered the scientific attitude scale to them. Again after one month the
same questionnaire was given to the same prospective science teachers and test was administered. Then reliability and validity was found to be 0.82 and 0.91. As these two results were too close to the test results, this SAS of Sood and Sanadhya were finalized for the final administration to measure the scientific attitude of prospective science teachers. This value shows that this scale is suitable for the present condition. The same scale is translated in to Telugu by the researcher with the help of research supervisor. The particulars of this SAS consists of six dimensions, viz., rationality, open-mindedness, curiosity, aversion to superstitions, objectivity of intellectual beliefs and suspended judgment. Scientific attitude scale contained 36 statements of which 18 are of negative polarity and 18 are of positive polarity.

**MEASUREMENT OF ATTITUDE TOWARDS SCIENCE SCALE**

Thrustone (1948) has 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. Many attitude scales have been prepared in the past three decades to study the attitude of people towards such issues as co-education, capital-punishment, Communism, U. N. O. etc. recently scales for measuring attitudes of teachers towards teaching (Ahluwalia, 1976), guidance services (Baker, 1966), towards science and scientists (Sood, 1975), towards micro teaching (Passi, 1977) have appeared. Scales for measuring attitude of student and teachers towards academic disciplines have also become popular. One of the objectives of
teaching science is to inculcate scientific attitudes among the pupils. The purpose of this scale would be to know whether or not the students have developed favourable attitudes towards science as a discipline. The underlying assumption being that one of the outcomes of science education is the development of positive attitude towards the subject. In India, there is a lack of standardized science attitude scales which may be available commercially for use by the teachers and research workers. Hence, it was thought that it is relevant to develop a dependable attitude scale for measuring the attitude of students towards science.

For developing the Science Attitude Scale (SAS), the researcher has accepted the definition of science attitude as an opinion or position taken with respect to a psychological object in the field of science (Richard W. Moore, 1970). The science attitude has, therefore, been operationally defined as a generalized attitude toward the universe of science content and being measured in terms of its favourableness or unfavourableness estimated from the scores obtained by the subject on an attitude scale towards science comprising of the four categories from the universe of content ‘Science Attitude’; (i) positive intellectual, (ii) negative intellectual, (iii) positive emotional, and (iv) negative emotional 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; (c) The method of successive intervals; (d) The method of summated
ratings also known as Likert technique; (e) Scalogram analysis; (f) The scale discrimination technique. Likert method and scale discrimination techniques were considered to be more appropriate for use in the construction of SAS. The construction of the scale was done through several procedural steps.

**Item Writing, Editing and Selection**

Before preparing the SAS, the investigator reviewed the relevant literature and other descriptive material dealing with the contribution of scientific thought. Students studying science and arts subjects were also asked to give reasons for and against the study of science. Some of the statements used were obtained from the relevant scales prepared by Sood (1975) and Test on Understanding of Science (TOUS).

While preparing the items for this Scale, the criteria mentioned by Edward (1975) have been followed. Precautions were taken to keep the reading level of the Scale well within the reach of the normative pupils. The universe of content for the attitude scale constituted forty-one statements about science collected from various relevant sources dealing with the world of science. In the process of collection, editing and selection the statement, the informal criteria as suggested by Wang (1932), Thurstone and Chave (1929), Likert (1932), Bird (1940), Edwards (1941), Zilling (1928) and Seeleman (1940), were carefully observed.

With a view to know the nature of the statements, the edited items were submitted to a group of five judges. These judges were specifically instructed to classify the 41 statements into two piles on the strength of the nature of the
statement- positive and negative. Classifying any one of these items into neutral category was discouraged. They were then requested to read the statements with a view to point out, if any, flaws, omissions and commissions in the grammatical structure of the statements. Out of the 41 items, 18 were classified as positive while 23 as negative items. Suggestions offered by judges were incorporated in the statements and they were further refined and improved. For further elimination of some more items of the scale, scale discrimination technique developed by Edwards and Kilpatrick (1948) was used. The scale discrimination technique eliminates the least discrimination items which other methods, including Likert's judging technique, fails to do.

Having known the nature, these items were edited into five point scale after Likert, and were then administered to a class of 100 representative pupils with the standard instruction weightages were assigned, and values as well as S values were calculated for item analysis purposes. These S values of the positive items were estimated to be 4.183 and 0.591 whereas of the negative items, they were found to be 3.677 and 0.445 respectively. Out of 41 statements, (18 positive, 23 negative), twenty items evenly distributed into four categories specified above, were retained for the final try-out. While selecting the 10 items from each category of statements, it was suggested to select items with low Q-values and with scale values which were spread over the entire scale at relatively equally spaced distances along the psychological continuum.
Try-out and Final Form

Researcher was finally left with 20-items after dropping the least discriminating items. The scale was then administered on 515 higher secondary students drawn from 6 schools of Bhopal. This was done with a view to determine the reliability, validity and norms of the scale.

Norms

As stated above, the scale can be scored in quite a simple manner by giving 4 points for strong endorsement of a positive statement; 3 points for the agreement and so on. The scoring is reserved for a negative statement. An individual’s raw score is the sum of his scores for the separate items. Most of the scales make use of raw scores only for the purpose of interpretation. But according to Thorndike and Hagen (1969) the raw scores can be converted into a percentile or standard score. Accordingly, percentile ranks and standard scores were determined for use and interpretation of the scale scores. Table-3.5 gives the percentile Rank equivalents of raw scores:
### Table-3.5: Giving Percentile Rank (PRS) equivalents of the raw scores

<table>
<thead>
<tr>
<th>Percentile Rank</th>
<th>Raw Score</th>
<th>percentile Rank</th>
<th>Raw Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 99</td>
<td>Above 64</td>
<td>33</td>
<td>46</td>
</tr>
<tr>
<td>99</td>
<td>64</td>
<td>30</td>
<td>45</td>
</tr>
<tr>
<td>98</td>
<td>63</td>
<td>25</td>
<td>44</td>
</tr>
<tr>
<td>97</td>
<td>62</td>
<td>22</td>
<td>43</td>
</tr>
<tr>
<td>96</td>
<td>60—61</td>
<td>18</td>
<td>42</td>
</tr>
<tr>
<td>89</td>
<td>59</td>
<td>14</td>
<td>41</td>
</tr>
<tr>
<td>87</td>
<td>58</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>86</td>
<td>57</td>
<td>6</td>
<td>39</td>
</tr>
<tr>
<td>85</td>
<td>56</td>
<td>5</td>
<td>38</td>
</tr>
<tr>
<td>84</td>
<td>55</td>
<td>4</td>
<td>36—37</td>
</tr>
<tr>
<td>72</td>
<td>54</td>
<td>3</td>
<td>35</td>
</tr>
<tr>
<td>70</td>
<td>53</td>
<td>2</td>
<td>31—34</td>
</tr>
<tr>
<td>65</td>
<td>52</td>
<td>1</td>
<td>27---30</td>
</tr>
<tr>
<td>63</td>
<td>51</td>
<td>less than 1</td>
<td>25---26</td>
</tr>
<tr>
<td>43</td>
<td>49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The below given Table gives the complete norms of the scale in Percentile Ranks, Standard Scores and Stannine. Verbal description and interpretation of the ranks obtained by a subject is also given in Table-3.6.
<table>
<thead>
<tr>
<th>Attitude</th>
<th>Range of PRS and Standard Scores (in brackets)</th>
<th>% of cases Included</th>
<th>Stannine</th>
<th>Verbal Description</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>65-69 and Above</td>
<td>99 and above (+2.29 to +2.85)</td>
<td>1%</td>
<td>9</td>
<td>Superior</td>
<td>Extremely Favourable</td>
</tr>
<tr>
<td>60-64</td>
<td>96.28—99 (+1.59 to +2.15)</td>
<td>5%</td>
<td>8</td>
<td>Above</td>
<td>Decidedly Favourable</td>
</tr>
<tr>
<td>55-59</td>
<td>84.08—89.20 (+0.89 to +1.45)</td>
<td>12%</td>
<td>7</td>
<td>Above</td>
<td>Fairly Favourable</td>
</tr>
<tr>
<td>50-54</td>
<td>60.12—72.72 (+0.18 to +0.75)</td>
<td>24%</td>
<td>6</td>
<td>Average</td>
<td>Somewhat Favourable</td>
</tr>
<tr>
<td>45-49</td>
<td>30.24—42.40 (-0.52 to +0.5)</td>
<td>30%</td>
<td>5</td>
<td>Average</td>
<td>Just Favourable</td>
</tr>
<tr>
<td>40-44</td>
<td>10.28—25.32 (1.22 to -0.66)</td>
<td>18%</td>
<td>4</td>
<td>Average</td>
<td>Somewhat Unfavourable</td>
</tr>
<tr>
<td>35-39</td>
<td>3.18—5.50 (-1.92 to -1.36)</td>
<td>7%</td>
<td>3</td>
<td>Below</td>
<td>Unfavourable</td>
</tr>
<tr>
<td>30-34</td>
<td>-1.16-1.96</td>
<td>2%</td>
<td>2</td>
<td>Below</td>
<td>Decidedly Unfavourable</td>
</tr>
<tr>
<td>25-29</td>
<td>-.10-00</td>
<td>1%</td>
<td>1</td>
<td>Low</td>
<td>Extremely Unfavourable</td>
</tr>
</tbody>
</table>
This Science Attitude Scale (SAS) was administered on 515 higher secondary students, 306 boys and 205 girls. The results obtained on the norming population, in terms of Mean and S.D. are given in tables 3,4 and 5.

In Table-3.7 mean and standard deviation of Science Attitude Scores of Science and Arts students by age are given.

Table-3.7: Mean and Standard Deviation of Science Attitude Scores

<table>
<thead>
<tr>
<th>Age in years</th>
<th>N</th>
<th>Science Students</th>
<th>SD</th>
<th>N</th>
<th>Arts Students</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>27</td>
<td>48.47</td>
<td>2.03</td>
<td>20</td>
<td>46.00</td>
<td>2.14</td>
</tr>
<tr>
<td>16</td>
<td>105</td>
<td>45.66</td>
<td>9.33</td>
<td>85</td>
<td>37.00</td>
<td>10.42</td>
</tr>
<tr>
<td>17</td>
<td>78</td>
<td>46.92</td>
<td>7.91</td>
<td>70</td>
<td>37.00</td>
<td>9.37</td>
</tr>
<tr>
<td>18</td>
<td>48</td>
<td>45.61</td>
<td>8.86</td>
<td>40</td>
<td>38.54</td>
<td>6.88</td>
</tr>
<tr>
<td>19</td>
<td>22</td>
<td>55.89</td>
<td>7.00</td>
<td>20</td>
<td>41.45</td>
<td>4.96</td>
</tr>
<tr>
<td>Combined</td>
<td>280</td>
<td>50.58</td>
<td>6.90</td>
<td>235</td>
<td>46.41</td>
<td>7.20</td>
</tr>
</tbody>
</table>

Mean and Standard Deviation of Science Attitude Scores of male and female students by age.
Table-3.8: Mean and Standard Deviation of Science Attitude Scores

<table>
<thead>
<tr>
<th>Age in years</th>
<th>N</th>
<th>Male Students Mean</th>
<th>SD</th>
<th>N</th>
<th>Female Students Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>37</td>
<td>49.30</td>
<td>6.97</td>
<td>17</td>
<td>46.40</td>
<td>7.44</td>
</tr>
<tr>
<td>16</td>
<td>102</td>
<td>45.40</td>
<td>8.45</td>
<td>82</td>
<td>43.70</td>
<td>10.45</td>
</tr>
<tr>
<td>17</td>
<td>80</td>
<td>45.33</td>
<td>9.42</td>
<td>60</td>
<td>46.80</td>
<td>7.97</td>
</tr>
<tr>
<td>18</td>
<td>56</td>
<td>44.70</td>
<td>8.29</td>
<td>30</td>
<td>42.40</td>
<td>9.05</td>
</tr>
<tr>
<td>19</td>
<td>31</td>
<td>55.75</td>
<td>6.93</td>
<td>16</td>
<td>43.00</td>
<td>7.92</td>
</tr>
<tr>
<td>Combined</td>
<td>306</td>
<td>47.00</td>
<td>8.25</td>
<td>205</td>
<td>43.37</td>
<td>8.85</td>
</tr>
</tbody>
</table>

Table-3.9: Mean, Standard Deviation & SE of the Mean of the norming population

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>SEm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Student Students</td>
<td>280</td>
<td>50.58</td>
<td>6.90</td>
<td>0.41</td>
</tr>
<tr>
<td>Art Students</td>
<td>235</td>
<td>46.41</td>
<td>7.20</td>
<td>0.46</td>
</tr>
<tr>
<td>Male Student</td>
<td>306</td>
<td>47.00</td>
<td>8.25</td>
<td>0.47</td>
</tr>
<tr>
<td>Female students</td>
<td>205</td>
<td>43.37</td>
<td>8.85</td>
<td>0.61</td>
</tr>
<tr>
<td>Combined</td>
<td>515</td>
<td>48.67</td>
<td>7.11</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Study of the results given in the above tables indicates that the science students have scored significantly \( (t = 6.62) \) higher than the arts students and
also the boys have obtained higher scores as compared to the girls which are also significant at 1 per cent level (t=5.04).

**Reliability**

The reliability of the Science Attitude Scale (SAS) was estimated by the split-half (0.86) and test-retest (0.75) methods which was found to be quite satisfactory. This is proved to be favourable with reliability (0.765) found by Sood (1975) for his scale of attitudes towards science and scientists. Reliability of the scale was further checked by two methods of scoring by administering the scale to a small sample of 50 subjects with instructions to check the statements in accordance with the usual Thurstone’s instructions and the science subjects were then asked to check for each item on one of the five alternatives in accordance with the usual Likert instructions. The coefficient of correlation found between the scores on two scales was 0.94. Ferguson (1941) reported a correlation of 0.82 between the Thurstone and Likert methods of scoring. The reliability Coefficients are given in Table 3.10.

<table>
<thead>
<tr>
<th>Method</th>
<th>Reliability</th>
<th>Coefficient</th>
<th>Reliability</th>
<th>SE of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Split-Half (Odd-even)</td>
<td>0.76</td>
<td>0.86</td>
<td>0.87</td>
<td>-2.63</td>
</tr>
<tr>
<td>2. Test-retest (3 months)</td>
<td>0.60</td>
<td>0.75</td>
<td>0.77</td>
<td>-3.55</td>
</tr>
<tr>
<td>3. Likert-Thurstone</td>
<td>0.94</td>
<td>0.96</td>
<td>0.96</td>
<td>+4.48</td>
</tr>
<tr>
<td>(Technique of scoring)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table-3.10: Reliability Coefficients and the SEs of their measurements

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Validity

The SAS appears to have content validity and the method of selecting items supports this supposition. In addition, differences in mean scores were found among the selected groups of known preference for science i.e. Arts (Means= 46.41) and Science (Mean= 50.58) students which is highly significant (t= 6.62) at 1 percent level.

Scoring

Each of the ten positive items of the scale is assigned a weight ranging from 4 to zero. In the case of ten negative items, the scale scoring is reversed ranging from zero to 4. The attitude score of a subject is the sum total of scores on all the twenty items of the scale. For each student, a total score on the scale can be obtained by summing his scores for the individual items. Thus a maximum of 80 scores can be obtained by a subject.

Time for Administration

The SAS is a self reporting inventory consisting of 20 items designed to assess the attitude of individuals towards science. There is no time limit but normally it takes about 5 minutes to explain the test and the subjects require about 15 minutes for giving responses to the items of the scale.

Relevance for the present study

After reviewing the available tests of attitude towards science, with the guidance of research supervisor, the attitude towards science scale developed by Avinash Grewal was adopted and the test items are translated in to the regional language to get the right response from the sample group of the
selected area and supplied to the science teachers and teacher educators to see the verbatim and difficulty level. The modifications suggested by the experts are carried out for the final version of the test. The reliability of the attitude towards science inventory was established by using test-retest method. The researcher has selected 200 prospective science teachers and administered the attitude towards science inventory to them. Again after one month, the same questionnaire was given to the same prospective science teachers and the test was administered. Then reliability and validity was found to be 0.89 and 0.94. This value shows that this scale is suitable for our condition. The same scale is translated in to Telugu by the researcher with the help of scholars in the field of science and language.

**Data Collection**

The investigator personally visited the selected colleges of education and administered the tests after taking permission from the administration. Before administering the test, clear instructions were given to the prospective science teachers and doubts were clarified. Tests were administered in ideal conditions. Thus, data was collected from the total sample, scoring was done and scores were assigned to each secondary school science teacher.