CHAPTER 1

INTRODUCTION

1.0 BACKGROUND OF THE STUDY

Man is highly intellectual creation of the nature. Man is the most powerful source of development of nation and the quality of people, which create the environment for glory and progress of nation. The National Policy on Education (1986) emphasized that human being is a positive asset and a precious national resource that needs to be cherished, nourished and developed with tenderness and care. Education is one of the most important human activities, which help the developmental process of a country. It opens the door of cultural civilization and modernization. There is a great impact of education on the level of mortality. In fact, educated people take care of their health by changing their life style and avail more chances of survival than the illiterate people. The educated people follow the hygienic rules and lead long life. Life is more secured now days by education. Because education plays an important role in shaping an individual's life opportunities, therefore it is generally agreed that the higher is a person's achieved educational status, the higher is the returns from that person in terms of economic and social status to the country. The educational status of an individual is highly depicted through the academic achievement. Education is a unique investment and academic achievement is a vital aspect of it. Therefore, academic achievement has become a potential index in determining present and future of the students.

Quality of education is mostly assessed on the basis of academic performance or academic achievement of students. Achievement is one of the important determinants of success in life, affecting people's work, interpersonal relationships, sense of being, and leisure. Academic achievement serves as a key criterion in order to judge students' true potentials and capabilities (Daulta, 2008; Nuthanap, 2007). Due to importance of achievement, each country in the world is trying to achieve higher level of students
achievement. Therefore, academic achievement has been one of the most important goals of the educational process and in educational process; examination is a key factor to determine the academic performance or achievement of students. A good examination system can be helpful in producing higher and quality achievers. But this is very true fact that a large number of students fail each and every year at secondary and higher secondary levels. Students who fail in the education system cannot be expected to become productive members of their communities. Dropouts are a drain on the economies of each state and the nation. State and local economies suffer due to failure of students in examination. Failure in examination is directly related to status of society and thereby tax revenues of state and central government of the country. This involves wastage of money and power. The nation's economy and competitive standing also suffers when there are high dropout rates. Dropouts represent a tremendous waste of human potential and productivity, and reduce the nation's ability to compete in an increasingly global economy. Failure of students in examination occurs a considerable lose on intellectual potency which hamper national development. Failure in examination is one major cause of teen-age student suicide also. Due to these reasons, failure in examinations has been a serious issue for teacher-educators, psychologists, doctors, counselors', teachers, parents and the governments. They are continuously trying to search reasons of failure or low marks in examination.

Generally, a question arises in the mind of the researchers working in this area that since schools are providing same facilities and same teacher to all students then why some students get distinction, some first class, some second class, some third class and some fail. Previously, this was general notion that intelligence is a main factor responsible for achievement. But researchers searching factors responsible for achievement observed that in various cases achievement of average students are higher and in some cases achievement of high intelligent students are lower. This indicates that intelligence is not a single factor responsible for achievement. Then a question arises that what are the other factors which are responsible for good academic achievement? After searching answer of this question, researchers concluded that these factors are nothing but non-intellectual or non-cognitive factors. Non-intellectual are socio-
psychological, biological, environmental, demographic variables that play significant
role in achievement of students. After recognition of non-intellectual factors as
predictors of academic achievement, several researches conducted related to non-
cognitive/non-intellectual factors and achievement. Some studies are also conducted
related to combination of cognitive and non cognitive factors in relation to academic
achievement. Some studies show positive impact of non-cognitive factors on
achievement while other found no significant impact of non-cognitive factors on
achievement. But majority of researches reveals that non-cognitive factors are playing
significant role in academic achievement of students. Some important findings in this
regard discussed below:

According to Bloom and Peter (1961) college success is a function of qualities or
attributes not directly related to intellectual ability. Qualities such as motivation,
interest, study habits, personality and social adjustment are few of the factors that have
been shown to affect academic achievement. Bhatnagar (1968) reported that many
students who pass in examination, failed to achieve in terms of their intellectual ability,
whereas, many students who failed in examination had higher intellectual abilities.

Haven (1965) in a review of the pre-1960 literature on the prediction of the
academic achievement concluded that intellectual ability was the best predictor which
accounted for 35% to 45% of the variance. Singh (1976) concluded that mental ability
tests of various sorts and under different levels were only of limited value in prediction
of scholastic success. According to this study, such mental ability tests contribute only
30 to 40 per cent of the variance in scholastic achievement. Rest of the variance has to
be accounted by other factors, not covered by intellectual abilities. Bloom (1976) also
analysed the data of 17 countries related to achievement of six different subjects and
concluded that 25% of the variance in science achievement can be attributed by school
environment and their self-concept, 25% variance has been attributed to quality of
instruction while only 50% variance contributed by cognitive factors. Shah and Kishan
(1982) found that intelligence contributes 18.74 percent to academic achievement.
Vattano (1987) concluded Wechsler's view that only 50% to 70% of variance accounted
for by all measurable intellectual factors. Rai (1990) also found in his study that logical
thinking and intelligence contributed only 34.50% of variance for understanding of concepts in physics. Pandey (2005) was found in her doctoral study that contribution of only achievement motivation on achievement in home science is 21.10%. While combined contribution of achievement motivation, age and some personality factors (B, E, G, Q2) was found 36.80% of variance on achievement of home science higher secondary school students.

It is clear from above that role of cognitive variable is significant on achievement of students but role of non-cognitive factor also significant on achievement of students. When investigator goes through several library and Internet she found that some other cognitive variables like logical thinking, science process skills are important factors responsible for achievement. Scientific attitude is also one of important factor responsible for achievement in science and other subjects. Some demographic variables such as sex, habitation and types of school also have been important field of research in achievement in science. Some studies were also found related to scientific attitude in relation to achievement. But in Indian scenario very few studies have been conducted related to logical thinking and scientific attitude in relation to achievement in science of students. Since, percentage of failure in science and mathematics have been higher in relation to other subjects, therefore, investigator decided to study achievement in science of higher secondary school students in relation to scientific attitude and logical thinking.

1.1 CONCEPT OF TERMS USED IN THE PRESENT STUDY

Understanding of concepts of terms used in investigation is essential for understanding work done by investigator. Concept of terms used in present study given below under different sub-headings:

1.1.1 Achievement

Achievement is the learned knowledge of a learner. The learner gains knowledge in school in different subjects through various subject teachers. The school provides a wide variety of activity to develop physical, mental and spiritual heal including subject knowledge. Attainment of these aspects is known as achievement. Merriam Webster
defines achievement as “the quality and quantity of a student's work.” According to Steinberger (1993) “Achievement encompasses student ability and performance; it is multidimensional; it is intricately related to human growth and cognitive, emotional, social, and physical development; it reflects the whole child; it is not related to a single instance, but occurs across time and levels, through a student’s life in public school and on into post secondary years and working life.”

The primary focus of education is academic achievement that has been measured using teacher made test or other forms of standardized examination. Academic achievement in general refers to the scores obtained in the annual examination or refers to the degree or level of success or ability attained in some specific area, concerning academic work. It is the degree of competence in school tasks usually measured by standardized tests. According to Oxford Advanced Learner’s Dictionary, “Achievement is a thing that someone has done successfully, especially using their own effort and skill.” An academic achievement is something you do or achieve at school, college or university - in class, in a laboratory, library or fieldwork.

Achievement is the act of reaching a goal. It is attainment, accomplishment, fulfillment, realization, or actualization of goal. It is success in attaining objectives, goals or aims. It is the extent to which learners fulfill their learning ambitions. An achievement must bring about change. Changes occur as in the acquisition of knowledge. If they do not occur there will be no meaning to the word achievement.

1.1.2 Achievement in Science

Science is comprised of physics, chemistry, biology and earth science. Understanding and attainment of concepts in science subject is known as achievement in science. Achievement in science was operationalized in terms of students’ score on science achievement.

Achievement in science means the success in science subject measured using a standardized test. Achievement in science in the present study is being considered as XII grade students scores on Science Achievement Test.
1.1.3 Attitude

Attitudes have long been considered a central concept in education, psychology and social science. Attitudes are an important concept that helps people to understand their social world. They help us define how we perceive and think about others, as well as how we behave toward them. Attitudes are a function of what we think and what we feel about object, place, person, etc. Attitudes have emotional content and vary in intensity and generality according to the range of objects or situations over which they apply. Attitude is a mental state, more or less enduring, representing a tendency to react favorably or unfavorably toward designated class of stimuli is attitude. Attitudes are product of belief and value. It is a behavior. Example of belief, value and attitude is given below:

My teacher is consultative. - Belief

Teacher consultation is good. - Value

My teacher is good. → Attitude

Belief + Value → Attitude → Behaviour

Many definitions exist that attempt to determine what exactly an attitude is. Some definitions of attitude are given below:

**Lundberg (1929):** An attitude denotes the general set of the organism as a whole toward an object or a situation which calls for adjustment.

**Bogardus (1931):** An attitude is a tendency to act toward or against something in the environment, which becomes thereby a positive or negative value.

**Cantril (1934):** Attitudes represent a more or less permanently enduring state of readiness of mental organization which predisposes an individual to react in a characteristic way.

**Morgan (1934):** Attitudes are literally mental postures, guides for conduct to which each new experience is referred before a response are made (pp. 47).

**Warren (1934):** Attitudes connote a condition of readiness for a certain type of activity.
Allport (1935) defined an attitude as "a mental and neural state of readiness, organized through experience, exerting a directive and dynamic influence upon the individual's response to all objects and situations with which it is related" (pp. 810).

Murphy, Murphy, and Newcomb (1937): "Attitude is primarily a way of being ‘set toward’ or against certain things" (pp. 889).

Krech and Crutchfield (1948): "An attitude can be defined as an enduring organization of motivational, emotional, perceptual and cognitive processes with respect to some aspect of the individual's world" (pp. 152).

Smith, Bruner, and White (1956): An attitude is a predisposition to experience, to be motivated by, and to act toward, a class of objects in a predictable manner.

Katz and Stotland (1959) define an attitude as a "tendency or disposition to evaluate an object or the symbol of that object in a certain way" (pp. 428)

Sherif, Sherif, and Nebergall, (1965): "Attitudes can refer to the stands the individual upholds and cherishes about objects, issues, persons, groups, or institutions. The referents of a person's attitudes may be a ‘way of life’, economic political or religious institutions, family, school or government" (pp. 4).

Ajzen (1975) viewed attitudes as being formed spontaneously and inevitably as individuals form beliefs about the attributes of an object. Attitudes, or the affective component of attitudes, are therefore linked to these beliefs that a person holds.

Attitudes are summary judgments of an object/event which aid individuals in structuring their complex social environments (Fazio, 1986).

Baron and Byrne (1997) definition of attitude is ‘Attitudes can be defined as lasting, general evaluations of people (including oneself), objects, or issues. Attitude is lasting because it persists across time. A momentary feeling does not count as an attitude.’

According to Schneider (1988), ‘Attitudes are evaluative reactions to persons, objects, and events. This includes your beliefs and positive and negative feelings about the attitude object.’

Eagly and Chaiken (1993): Attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor.
Vaughan and Hogg (1995) wrote ‘Attitudes are relatively permanent- persist across times and situations. A momentary feeling in one place is not an attitude.’ Again the define attitude as, ‘A relatively enduring organization of beliefs, feelings and behavioral tendencies towards socially significant objects, groups, events or symbols or a general feeling or evaluation (positive/ negative) about some person, object or issue.’

Attitude has often been defined by social psychologists in terms of three factors; cognitive beliefs about a person or object, affective or evaluative feelings about that person or object, and behavior toward that person or object. Including these three components, a comprehensive definition was given by Salta and Tzougaki (2004) that attitude is a tendency to think, feel or act positively or negatively toward objects in our environment, and can be viewed as having three main components:

1. *Cognitive Component* - is a set of beliefs about the attributes of the attitudes and its assessment can be performed using paper-and-pencil tests (questionnaires);
2. *Affective Component* - includes feelings about objects and its assessment can be performed using psychological indices:
3. *Behavioral Component* - pertains to the way people act toward objects and its assessment can be performed by directly observing behaviors.

Reid (2006) also provides a similar component related definition of attitude as follows:

1. a *knowledge about the object*, the beliefs, ideas component (Cognitive);
2. a *feeling about the object*, like or dislike component (Affective); and
3. a *tendency-towards-action*, the objective component (Behavioural).’

Therefore, attitude is cognitive, affective and behavioural construct that represents an individual's feeling or likeness (like or dislike) about an object or person or phenomenon. In other words, a predisposition or a tendency to respond positively or negatively towards a idea, object, person, or situation.

### 1.1.4 Logical Thinking

The study of cognitive process has an important area of psychological and educational investigations. Generally terms like logical reasoning, logical thinking and cognitive developmental level are used for similar purpose. Logical thinking is a process
of solution of a problem in which one uses reasoning consistently to come out a conclusion. Problems or situations that involve logical thinking call for structure, for relationships between facts, and for chain of systematic reasoning that make sense. In other words, logical thinking is the process of using a rational, systematic series of steps based on sound reasoning and given statements to arrive at a conclusion. Logical thinking is to think on the basis of knowledge, what we know, and certainties. Logical thinking is the part of the brain that relates to its left-hand side. Logical (or left-brain) thinking comes into its own when we are working with verifiable and reasonably certain information. This is information we can be sure about because it has been confirmed scientifically.

Cognitive development in its purest sense refers to changes in the individual’s level of cognitive functioning. During the past half 20th century, several developmental have been given by the theorists. In these theorists Sigmund Frud, Erik Erikson, Arnold Gesel, Robert Havighurst, and Jean Piaget contributions are more valuable. But in the field of cognitive development Piaget theory is superior and still standing in present time with strongest. No theory of cognitive development had more impact than that of Jean Piaget, a Swiss psychologist. He suggested that children proceed through a series of four separate stages in fixed order that is universal across all children. He mentioned that these stages differ not only in the quantity of information acquired at each level, but in quality of knowledge and understanding as well.

The developmental milestone theory of Jean Piaget presented in outline form. Piaget’s (1953) four stages are known as the sensory motor, pre-operational, concrete operational and formal operational. Characteristics of these four stages or levels or phases are given below:

1.1.4.1 Sensory-Motor Stage (0-2 years)

The sensory-motor stage starts with reflexes and ends when language is acquired at the initial stage. During this period internalized thinking is absent. It is manifested by overt behaviour.
a. **Use of Reflex** (0-1 month): There is continuation of parental reflexes. They are spontaneous repetitions caused by internal and external stimulations. Rhythm is established through practice and habits are formed.

b. **Primary Circular Reaction** (1-3 months): Following development occur at this period:
   1. Reflexive movement is gradually replaced by voluntary movement.
   2. Neurological maturity must be reached first before sensations can be understood.
   3. Previous automatic behavior is repeated voluntarily.
   4. More than one sensory modality can be used at a time
   6. Primary circular reactions refer to the assimilation of a previous experience and the recognition of the stimulus that triggers the reaction.
   7. New and past experiences have no meaning unless they become part of primary circular reaction pattern.

c. **Secondary Circular Reaction** (3-9 month): Following development occur at this period:
   1. The infant tries to make events last and tries to make events occur.
   2. The focus of the infant is on retention, not repetition
   3. The infant tries to create a state of permanency.
   4. Primary circulation reactions are repeated and prolonged by secondary reactions.
   5. Two or more sensory-motor experiences as related to one experimental sequence of schema.
   6. Vision is the prime coordinator but other sensory modalities are also used.
   7. Imitation, play, and emotion being to appear at this stage.

d. **Application of the Secondary Schema to New Situation** (8-12 months): Following development occur at this period:
   1. Child’s ability to distinguish means from ends (i.e., producing the same results more than one way).
   2. The child uses previous behavior achievements primarily as the basis for adding new ones to his expanding repertoire.
   3. There is increased experimentation, ends and means are differentiated by experiments.
4. Adaption is an end result of experimentation.
5. The infant can experience action by observation.
e. *Tertiary Circular Reaction* (12-18 months): Following development occur at this period:
   1. There is discovery of new means through active experimentation.
   2. The beginning of curiosity and novelty seeking behavior are developing.
   3. Reasoning comes into play and is developed.
   4. Failure to remember is failure to understand.
   5. The infant develops spatial relationships upon discovering objects as objects.
   6. Imitation develops.
   7. Play is very important because it repeats the action phase.
f. *Invention of New Means Through Mental Combination* (upto 2 years): Following development occur at this period:
   1. There is a shift from sensory-motor experience to an increased reflection about the experiences.
   2. Objects become permanent. Child discerns himself as an object among many and perceives and uses objects for their own innate qualities.
   3. The child begins to relate the object to new action without actually perceiving all of the actions.
   4. Sensory-motor patterns are slowly replaced semi-mental functioning.
   5. Imitation copies the action itself or the symbol of the action.
   6. Parallel play comes into existence.
   7. Identification, as a mental process, becomes evident at the end of 2 years. It depends on intellectual development of child.
   8. This period is characterized by the creation of mass and not merely the discovery of means.

**1.1.4.2 Pre-operational Stage (2-7 years)**

During this period children acquire the internalization of thought process which they lacked as infants. But the internalization of actions does not take place at this stage in which the child can make use of a system of operations. The development during this
period can be conceived of as preparing the way for the achievement of operations through increasing coordination of assimilation and accommodation in the child's symbolic activities. The pre-operational period is divided into two. The first ranges from two to four years. This period is marked by egocentric speech and primary dependence on perception. The second period is between five to seven years. During this period intuitive thought develops. Following activities are related at this stage:

**2 – 4 Years**

1. Continuous investigation of his world develops.
2. The child knows the world only as he see it.
3. The child is egocentric rather than autistic, as in the sensory-motor stage.
4. Assimilation of the paramount of the child.
5. Play occupies most of his awake hours.
6. Imaginary play is important.
7. Language repeats and replaces sensory-motor history.
8. Events are judges by outward appearance regardless of their objective logic.

**Intuitive Though Stage (4-7)**

9. There is a widening social interest in the world about him.
10. There is reduced egocentricity and increased social participation.
11. The first real beginning of cognition occurs here.
12. Speech replaces movement to express thinking.
13. The child can think of only one idea at a time.
14. The child becomes aware of relationships.
15. The child aware with quantity and learn numbers.
16. Know the rules and values of elder.
17. Play with similar age children.

**1.1.4.3 Concrete Operational Stage (7-11 years)**

At this stage children's thought process loses their intuitive character. It becomes more logical. This stage is the turning point in the entire course of cognitive development. Piaget holds that mental operations at this stage can be grouped into two broad categories: (a) logico-arithmetic operations and (b) spatial operations. The logico-
arithmetic operations involve discontinuous information and spatial operations involve continuous information. Following are the characteristics of a child at this stage:

1. The child becomes aware of alternative solutions.
2. The child acquires reversibility which is the capacity of relating an event or thought to a total system of interrelated parts in order to conceived the event or thought from beginning to end or end to beginning.
3. It is the capacity to order and relate experiences.
4. Mental experimental at this level still depends on perception.
5. The child examines part to gain knowledge of whole.
6. The child classifies parts and organizes parts into hierarchical system.
7. Perceptions are more accurate.
8. Play is used to understand physical and social world.
9. Play loses assimilative traits and develops cognitive thought.
12. The child at this stage conserving (understanding that quantitative relationships between two objects remain invariant in the face of irrelevant perceptual deformations of one of the objects) number, length, weight, area, volume, and related tasks.

1.1.4.4 Formal-Operational Stage (11 – 16)

According to psychologists, this is the period of emotional instability which may create adjustment problems. But for Piaget, it is the most exhilarating and productive period. During this period adolescent demonstrates thinking and reasoning abilities. The adolescent at this stage develops logical abilities. Following are the major characteristics of formal thinkers:

1. At this stage childhood ends and youth begins.
2. Individual enters in the world of ideas.
3. There is systematic approach to solving problems.
4. Individual imaging dimensions of past, present and future problems.
5. Formal-operational thinkers are capable of reasoning verbally even in the absence of concrete object.

6. Hypotheses about what logically might occur under different combinations of factors.

7. The adolescent begins to imagine the situation under certain hypothetical sets.

8. He can set up a hypothesis in a given situation, deduce what would happen if it was true, check and verify if the facts in front of him are consistent with his deductions from the hypothesis.

9. Child makes decisions on the basis of cause and effect.

10. With the formal-operational thought the child can understand in an analytic rather than in an intuitive sense.

11. One would not accept reality or empirical results from concrete phenomena unless and until it is verified through all possible consequences.

12. This is a stage of reversal of direction between reality and possibility.

13. One at the formal-operational stage would formulate statements about possible solutions in the form of propositions.

14. Person would be capable of generating second-degree operations or propositions that were inter propositional.

15. It is the highest level in the development of mental structure.

According to Piagetian theory at the age of 15 – 16 most students can achieve formal operational level. But various studies given in above section of present studies show that most of students in this age group do not reach at formal operational. Piaget also recognizes this problem. According to this theory this is the last stage of cognitive development. A question arises here that cognitive level does not develop after this age. Epstein (1974, 1978) has provided valuable insights into the maturation process, particularly the brain growth and supplies as one possible source of neurobiological support for the Piagetian model of cognitive development. Epstein's research indicates that the growth of human brain occurs in spurts rather than in simple linear increments across time. Epstein identified a fifth stage of brain growth without creating hindrance in the original Piagetian model. Piaget (1972) pointed out the possibility of the existence of such a stage. Arlin (1975) and
Riegel (1973) also proposed such a stage within the Piagetian model. The parallel between Epstein's brain growth periods and the Piagetian stages in the development of logical thinking, including the fifth stage given in Figure-1.1.

![Figure-1.1: Parallel between Epstein’s brain growth and Piaget’s Stages of Cognitive Development (Brooks et al., 1983).](image)

According to this model fifth stage of cognitive development was introduced.

**Steps of Logical Thinking**

Logical thinking uses 5 steps:
1. **A clear goal or solution**: Working towards clear goals is often described by the mnemonic SMART. These are goals which are specific, measurable, achievable, realistic and time-bound.

2. **Systematic planning**: Systematic planning is the second step in the SMART process towards a goal. We know the "what?" because we have defined a clear goal; systematic planning tells us the "how?" to get us there. Systematic planning aims to find the correct method, the correct procedure, the correct system that can logically take us to our goal.

3. **Using information**: The remaining steps in the SMART process involve using our left-sided brains to work towards our goals. Information is key to this process. We need to group it, organize it, rank it, fit it into the bigger picture, and make connections with it.

4. **Reasoning**: After getting information thinking process needs reasoning to see association between or among information. At this stage the thinker adapts inductive or deductive approach of reasoning. But combination of both approaches is very fruitful for logical thinking.

5. **Judgment and Decision Making**: This is last step of logical thinking. After reasoning, the thinker judges conclusions of reasoning and takes right decision on the basis of judgment.

### 1.1.5 Science

Science is a school subject, comprising of a course in physical and biological sciences. Physical science consist physics, chemistry and earth 'science'. Biological science consist zoology and botany. Etymologically, the word science is originated from a Latin word *scientia*, which means ‘to know’ therefore, an originated effort to know about the things is science. Science is search for cause of natural phenomena and other events for knowledge and truth. Through science man has accumulated a vast store of knowledge. Science is a product of human activity in the form of systematic and organized body of knowledge. It is a process of searching new concepts, generalization, generates laws and theories on the basis of vast found of accumulated knowledge.
Science includes the investigation of new phenomenon, analyzing ideas and comparing previous theories. It is an investigation of observation, identification, and theoretical explanation of the phenomenon occurring in nature.

According to Fitzpatrick (1960) "Science is a cumulative and endless series of empirical observations, which result in the formation of concepts and theories with both concepts and theories being subject to modification in the light of further empirical observations. Science is both a body of knowledge and a process of acquiring it".

Science is both process as well as the product of the process. In its process form it suggests the ways and means of exploring the truth and in its product form it presents systematic and organized body of useful knowledge. The process form of the science is more important than its product form in exploring the truth and acquiring knowledge. The process form is always given more preference in science because it enhances understanding of concept. Science is always busy in search for truth. But science does not consider truth as absolute and permanent. In short it can be said that science is an organized and systematized continuous process of searching new truth and knowledge.

1.1.6 Scientific Attitude

Scientific attitudes regarded as a complex of values and norms of science. The norms are expressed in the forms of prescriptions, proscriptions, preferences and permissions. The scientific attitude is a scientific act or thought. It is way of thinking in scientific way. Reliable, practical and scientific opinions, beliefs, feelings, thinking and appreciations are known as scientific attitude. Several definitions of scientific attitudes have given on the basis of characteristics of scientific attitude. Characteristics of scientific attitude given by different researchers are given below:

Curtis (1924) first characterized scientific attitude in following four aspects:

1. Conviction of universal cause and effect relationship
2. Habit of weighing evidence
3. Habit of delayed response and
4. Open-mindedness

Dewey (1933) defined scientific attitude in terms of following characteristic:
1. An ardent curiosity

2. Fertile imagination and

3. Love to experimental enquiry

**Noll (1942)** defined the scientific attitude in terms of the following six habits of thinking:

1. Habit of Intellectual honesty
2. Habit of looking cause and effect relationship
3. Habit of suspended Judgment
4. Habit of open mindedness
5. Habit of criticism, including self-criticism and
6. Habit of accuracy in all operations, including calculation, observation and report.

**Brumester and Noll (1854)** defined scientific attitude in terms of following characteristics:

1. Belief in cause-and-effect relationship
2. Open-mindedness
3. Freedom from superstitions
4. Suspended judgment
5. Freedom from prejudice and
6. Intellectual curiosity

**Peel (1955)** included following characteristics of scientific attitude:

1. Belief in cause and effect relationship
2. Open mindedness
3. Freedom from superstition
4. Suspended judgment
5. Freedom from prejudice, and
6. Intellectual curiosity

**Haney (1964)** listed following eight characteristics of scientific attitude:

1. Curiosity
2. Rationality
3. Willingness to suspended judgment
4. Open-Mindedness
5. Aversion to superstitions
6. Objectivity
7. Intellectual honesty and
8. Humility and reverence for life

Diederich (1967) listed following twenty components of scientific attitude:

1. Scepticism (not taking things for granted)
2. Faith in possibility of solving problems
3. Desire for experimental verification
4. Precision
5. A liking for good things
6. Willingness to change opinion
7. Humility
8. Loyalty to truth
9. An objective attitude
10. Aversion to superstition
11. Liking for scientific explanation
12. Desire for completeness of knowledge
13. Suspended judgment
14. Distinguishing between hypotheses and solutions
15. Awareness of assumptions
16. Judgment of what is of fundamental and general significance
17. Respect for theoretical structures
18. Respect for qualification
19. Acceptance of probabilities and
20. Acceptance for warranted generalizations.

Billeh and Zakariades (1975) identified the following six correlates of scientific attitude:

1. Rationality
   (a) Commitment to the value of rationality
   (b) Tendency to test traditional beliefs
(c) Seeking for natural cause of event and identification of cause and effect relationships
(d) Acceptance of criticalness
(e) Challenge of authority

2. Curiosity
(a) Desire for understanding now situations that are not explained, by the existing body of knowledge
(b) Seeking to find out the 'Why' and 'How' of observed phenomena
(c) Give questioning approach for novel situations
(d) Desire for completeness of knowledge

3. Open-Mindedness
(a) Willingness to revise opinions and conclusions
(b) Desire for new things and ideas
(c) Rejection of singular and rigid approach to people, things, and ideas

4. Aversion to Superstitions
(a) Rejection to superstitions beliefs
(b) Acceptance of scientific facts and explanations

5. Objectivity-Intellectual Honesty
(a) Demonstration of the greatest possible concern for observing and recording facts without any influence of personal pride, bias or ambition
(b) In interpreting results, there is no place of any modifications according to present social, economic or political conditions

6. Suspended-Judgment
(a) Unwilling to draw inferences before evidence is collected
(b) Unwilling to accept as facts and things that are not supported by convincing proof
(c) Avoidance to quick Judgment and Jumps to conclusions

The above six general components of the scientific attitudes with the specific behaviour of each were used for the construction of an instrument for measuring the scientific attitude.
According to Chitambar (1977) following are the major characteristics of scientific attitude:

A. Evidence of Facts: Knowledge must be based on clear evidence of facts.
B. Objectivity: Objectivity means the willingness and ability to see things.
C. Precision: When scientific observations are made, it is extremely important that these describe situation or persons as they actually do exist at the time of observation, this is accuracy.
D. Qualification: Qualification overcome the dangers of generalisation made on the basis of limited observation, and
E. Measurability

James (1995) included following characteristics of scientific attitude:

1. Honesty
2. Open-mindedness
3. Patience
4. Curiosity
5. Humility and
6. Skepticism

On the basis of above literature the investigator arrived on conclusion that scientific attitude consists following main characteristics:

1. Curiosity
2. Rationality
3. Willingness to suspend judgment
4. Aversion to Superstitions
5. Freedom from prejudice
6. Open- mindedness
7. Critical mindedness
8. Objectivity
9. Intellectual honesty
10. Humility
11. Truthfulness
12. Skeptism or Scepticism (not taking things for granted)

13. Precision

Meaning of these terms explained below:

1. Curiosity

Curiosity is an innate capability of many living beings. Everyone wants to understand new situations in general life. Learners get so many new situations if they open science books but it is a question that how many of them are interested to understand them. Curiosity is an energizing factor that arouses exploratory behaviour. In this exploration, the individual is partially oriented toward stimulus change and partly towards Novelty. The curious person not only sees and hears but looks for and listens for. A curios person asks questions, find information’s, initiates and carries out investigation. Curiosity is a process of inquiry, stimulus and produce reliable outcome. Each discovery raises new questions and suggests new solutions. Pupils should show great curiosity for the science courses. Curiosity can be learned in classroom. Hard/tough/problematic situation or problem not answered and explained immediately in classroom can stimulate curiosity of students. The solution of problems should raise new problems. In this way curiosity again generates.

2. Rationality

According to Business Dictionary.com rationality is a mental state of a rational person characterized by beliefs that are coherent (not contradictory) and compatible with the person's experience within a given context, purposeful (intended to produce certain results) behavior guided by means-versus-ends analysis, decision making based on cost-versus-benefit (pain-versus-gain) evaluation and an overall optimization approach (utility maximization), expressed in attempts to maximize advantages or gains and to minimize disadvantages or losses.

Rationality is the quality or state of being reasonable, based on facts or reason. It implies the conformity of one's beliefs with one's reasons to believe, or of one's actions with one's reasons for action. Rationality includes commitment to the value of rationality, tendency to test traditional beliefs, seeking for natural cause of event and identification of cause and effect relationships, acceptance of criticalness and challenge of authority.
3. Willingness to Suspend judgment

Willingness to suspend judgment is a cognitive process and a rational state of mind in which one with holds judgments. In this process, persons take a conclusion or making a judgment after verification of reality of facts. A person with scientific attitude not forms an opinion on a given issue until he/she has investigated it. This is closely related to a desire to investigate before acting to act all the relevant facts if immediate action is necessary. Persons with this scientific attitude accumulate sufficient evidence before making judgment or drawing conclusion. Willingness to suspend judgment mainly demand unwilling to draw inferences before evidence is collected, unwilling to accept as facts and things that are not supported by convincing proof, avoidance to quick judgment and jumps to the conclusions.

4. Aversion to Superstitions

A superstition is the belief that influences events by specific behaviors without having a causal relationship. Superstition is derived from two Latin words *super* means over or beyond and *sto, stare* means to stand. Therefore, superstition means one who overly stands, or not being progressive. It is a false belief based on ignorance, fear of the unknown, trust in magic, trust in chance or some other false conception of causation.

5. Freedom from Prejudice

Prejudice means favorable or unfavorable attitude without knowledge, thought, or reason. It is also a preconceive favorable or unfavorable opinion or attitude.

6. Open- Mindedness

Open-mindedness is an intellectual aspect that involves a willingness to take relevant evidence and argument into account in forming or revising our beliefs and values. Open mindedness means a person ready to accept other view on the basic of reliable logic or evidence. Open-minded consider willingness to revise opinions and conclusions, desire for now things and ideas and rejection of singular and rigid approach to people, things, and ideas.

7. Critical Mindedness

Critical mindedness is a mental ability to judge merit or quality of an idea, method and other things. A person with critical mindedness looks for evidence and arguments
that support other person’s assertion. Persons with critical mindedness are not only new idea generator but they also think that their idea is logical or not.

8. Objectivity

Objectivity is related to reality and truth. Generally, objectivity means the state or quality in terms of biases, interpretations, feelings, and imaginings. A scientist is objective in gathering and interpreting his ideas and is fair in communicating his findings. Objectivity means speak without imposing self wishes on it, report the results of experimentation as accurately, and interpret them as fairly as possible.

9. Intellectual Honesty

Intellectual honesty is honesty adapted by persons in the acquisition, analysis, and transmission of ideas. A person is being intellectually honest when he or she present and state their knowledge truly. According to Wikipedia intellectual honesty is an applied method of problem solving, characterized by an unbiased, honest attitude, which can be demonstrated in a number of different ways:

- One's personal beliefs do not interfere with the pursuit of truth;
- Formal Communication Layouts are used on paper, TV, radio and Internet;
- Relevant facts and information are not purposefully omitted even when such things may contradict one's hypothesis;
- Facts are presented in an unbiased manner, and not twisted to give misleading impressions or to support one view over another;
- References, or earlier work, are acknowledged where possible, and plagiarism is avoided.

10. Humility

The term "humility" comes from the Latin word *humilitas* (noun) and *humilis* (adjective) which may be translated as "humble". Since humility derived from *humus* (earth) also perceive as "grounded", "from the earth", or "low". In this sense, humility is considered as act or posture of lowering oneself in relation to others or to God. The first definition of “humble” in the Oxford English Dictionary is “Having a low estimate of one’s importance, worthiness, or merits.” This means that humility is a compelling and attractive quality in a person. Person having this quality does not think of himself as very important, is very submissive, and does not stand up for himself, but allows him to be
pushed around. Humility occurs in the heart of a man or woman. It is always measured in terms of submission to others.

11. Truthfulness

Truthful means that we can grow and mature, through learning from our mistakes.

**Truthful people will:**

- Understand themselves, and know their own strengths and weaknesses. They will not delude themselves about their successes or failures;
- Present themselves in a way that shows who they really are. Their reputation will be founded on what they are and, whether in public or private, they will be the same;
- Meet any commitments or promises that they make;
- Be accurate in their descriptions of themselves or others, so that they do not mislead others.
- A rule or statement that conforms to fact or reality.

12. Skepticism or Scepticism (not taking things for granted)

There is no difference between *skeptic* and *sceptic*. Skeptic is the preferred spelling in American and Canadian English, and sceptic is preferred in the main varieties of English from outside North America. This extends to all derivatives, including *sceptical*/*skeptical* and *scepticism*/*skepticism*. Scepticism or skepticism is disbelief in any claims of ultimate knowledge, a lack of conviction or certainty. According to Higgitt (2013) “Scepticism, or skepticism, is neither denialism nor a movement. Based on the Greek *skeptomai*, which means to think or consider, it usually means doubt or incredulity about particular ideas, or a wider view about the impossibility of having certain knowledge. This uncertainty is a philosophical position, and philosophical scepticism includes attempts to deal with it, through systematic doubt and testing of ideas.”

13. Precision

Accuracy and precision are defined in terms of systematic and random errors. Accuracy means how close a measured value is to the actual or true value. Precision
means how close the measured values are to each other. Therefore, precision is extremely accurate measurement or operation. It is closeness among measurement or observation.

1.2 TITLE OF THE PRESENT STUDY

Formal title of the present study was

“A Study of Certain Correlates of Science Achievement at Higher Secondary Stage”

1.3 RATIONALE OF THE STUDY

Education is a strong key of development in all spheres of the world. It is a key of success of individual and any nation. It is generating good human that are helping to living and non-living things in their survival. Due to significant role of education, recently international organizations have clearly been paying more attention to achieve goal of education for all. For instance, in April 2000 the participants of the World Education Forum committed themselves to the goal of providing education for all by the year 2015.

Education is related to achievement of students in different subjects. Science is one of the very important subjects in school system and higher education. Science education plays key role to build up rational attitude in human being. An education in science helps us to break superstitions and conventional ideas and develop scientific attitude, analytical thinking and logical thinking in learner. Science has further enabled human beings to open secrecy of nature. It has changed the outlook of people about themselves and the world around them. Science is considered as a development of culture and a synonym of progress. The progress and prosperity of any nation is determined by its standards in science and technology. The development in science and technology has influenced every sphere of human life. It has presented new challenges before life. Science is introduced heavily in our life. Many incidents are occurring around us and in most of incident science appears. Use of scientific instruments and knowledge is necessity of life. Without science it is difficult for a man to continue with his life because every where is science. Development of the science and technology, new inventions and
discoveries are made every day and some of these have great impact on whole society of the world. Due to fast development through science, present era is known as era of science and technology. Therefore, the demand of present time necessitates that all students in schools or in community must have some understanding of science and technology along with its latest role in society.

Importance of science has influenced various commissions in our country. The secondary Education commission (1953) has recommended the teaching of general science as a compulsory subject in the high and higher secondary schools. Indian Education commission (1966) recommended that "Science and mathematics should be taught on a compulsory basis to all pupils as a part of general education during first ten years of schooling. Also science teaching should be linked to agriculture in rural areas and to technology in urban areas". The National Policy on Education (1986) cleared that "science education must be strengthened as to develop in the child some well defined abilities and values like spirit of enquiry, creativity, objectivity courage to question and aesthetic sensitivity". National Policy on Education (1992) remarked that “Science educators have the role of providing such scientifically literate citizens to the nation. To fulfill its expectations, citizens should be scientifically literate, skilled in the processes of science, acquire scientific information in depth and cultivate an appreciation for science."

Science education in school curriculum, especially at secondary and higher secondary school stage, is a necessity because science education gives training to individuals in scientific method and helps to develop a scientific attitude and inculcates in them a spirit for scientific enquiry. It develops the capacity to utilize scientific knowledge for the solution of man's problem. It must inculcate scientific temperament in learner. It provides unique training in truth imparts the capacity to know the unknown, develop logical thinking and creativity and improves inner state strength of learner. These are highly useful and transferable to other life situations also. But it is very shocking that in present world of science and technology a good number of students are failing at secondary and higher secondary level. Science education has become highly commercial and academic excellence has gained through high and tough competitions. Students are facing more competition during getting education. Today competitive examination is
essential part of admission in good educational institutions. It is reality that in highly prestigious school higher achievers also fail to get admission. Therefore, in front of teachers, administrators, educators, policy makers and researchers, a striking question has sustained since long time that how student achievement level in science and other subjects can improve and overcome failure.

The main reason behind failure in examination is lack of concept formation, concept attainment and concept understanding in science subjects or other subjects. Formation/attainment/understanding of concepts in any subject are mostly an individual affair. It is also influenced by a number of socio-psychological, biological, environmental and demographic variables. Attitude and logical thinking ability are two main individual factors play significant role in understanding of concept and thereby achievement in science.

Attitude is an effective and play significant role in achievement in science and other subject also. Scientific attitude is a way of thinking in scientific way which is essential condition for achievement in science. It is also helpful in development of humanity. Learners with proper scientific attitude can adjust themselves well and live as efficient citizen in a scientifically advanced society. Pupils with high degree of scientific attitude show greater achievement in science subjects. Some studies (Bhattacharya, 1997; Kaur, 2001; Mukhopadhyay, 2013; Ksheerasagar and Kavyakishore, 2013; Olasehinde and Olatoye, 2014; Rao, 1996; Shinde, 1982; and Panneerselvam and Muthamizhselvan, 2015) conducted related to scientific attitude achievement in science and found that both are related significantly and positively.

Logical thinking is another most important factor playing significant role in achievement in science. Several studies have been conducted related to achievement in science and logical thinking. Most of researches indicate that both concepts are correlated significantly. Results of some studies also indicated that logical thinking not influencing achievement in science. Finding of several studies indicates that most of student in classroom have on concrete operation level, while very few students reached at formal operational level. Researchers believe that due to failure to reach at formal operational level of logical thinking student no able to understand concepts in science. Bigs and
Collins (1982) reported that students at the concrete operational level have an inefficient working memory and have difficulty to take multiple concepts simultaneously and they fail to recognize the problem. Concrete operational students often consider a problem to have a single correct solution and have difficulty to identifying responses for open-ended questions that have multiple answers. Formal operational students have deep working memory so they are able solve abstract problems in logical fashion, becomes more scientific in thinking such as testing the hypothesis and analyzing data. They can keep concepts and their inter-relationships in their mind while considering answers of the problem.

Previous studies show lack of formal operational level in secondary and higher secondary level students. Dulit (1972) found that normal students (aged 14-17) reached only 25-33% at formal operational level, while gifted students (aged 16-16) reached 60% at formal operations level. Renner and Stafford (1972) studied developmental level of junior high school students (grades 7, 8 and 9) and senior school students (grades 10, 11 and 12) living in various parts of Oklahoma using six Piagetian tasks. Result indicates that 77% junior high school students were concrete-operational, 14% were post-concrete-operational, and 6% were formal-operational. Lawson (1974) studied developmental level of biology, chemistry and physics students using six Piagetian type tasks. His results showed that 64.8% of the biology, 22% of the chemistry, and 36.3% of the physics subjects were at the concrete operational level, while 35.2% of the biology, 78% of the chemistry, and 63.7% of the physics students were at the formal-operational level. Nordland et al. (1974) studied the reasoning ability of seventh grade students (age range 11.7 to 12.6 years) from a predominantly Black and Spanish-American urban junior high school by using ten Piagetian tasks. The results indicated that 83.4% of the students were at the formal-operational level. Bady (1977) studied logical ability of ninth grade, eleventh grade and college students and found that a success rate by college students, eleventh grade and ninth grade students were 40%, 15% and 5%, respectively. Upadhyay (1978) studied tenth grade science students and reported that majority of the fifteen years old do not operate at the formal level. El-Sowygh (1982) studied logical thinking of Saudi Arabian college students and found that 15.7% students reached at formal
operational level, 39.5% in a transitional level and 14.8% at the concrete level of operations. Hale (1982) found that only 4% of the medical students demonstrated formal operations and 96% were in the transition from concrete to formal operations. Pandey (1987) studied logical thinking of XI grade science students and found that majority of students (71%) are functioning at the concrete-operational level and only 29% students show formal-operational thinking. It is clear that majority of students learning in high school and higher secondary school fails to reach at formal operational level of logical thinking.

Science achievement related to demographic variables like gender, location and type of schools have been a field of investigation. Several studies have been conducted and their finding produced contradictory results. Some results indicate differences while some show not difference between these variable. Therefore, to know differences between male-female, rural-urban and difference between different types of schools is essential in fast changing society and science and technology. From this point of view present study is needful.

Particularly in Sangrur district of Punjab not a single study conducted related to achievement in science in relation to scientific attitude and logical thinking. Therefore, this study is needful.

Since, logical thinking, scientific attitude and demographic variables play significant role in science achievement, therefore, investigator decided to study achievement in science of higher secondary science students of Sangrur District in relation to scientific attitude, logical thinking and some demographic variables (sex, location and types of schools).

1.4 OBJECTIVES OF THE STUDY

Following objectives were framed for the present study:

1. To find out significant difference among high, moderate and low science achievers on scientific attitude of rural male, rural female, urban male, urban female higher secondary school students.
2. To find out significant difference among high, moderate and low science achievers on logical thinking of rural male, rural female, urban male, urban female higher secondary school students.

3. To find out significant difference between male and female higher secondary school students on achievement in science for rural government, urban government, rural private and urban private categories.

4. To find out significant difference between rural and urban higher secondary school students on achievement in science for male Government, female Government, male private and female private categories.

5. To find out significant difference between Government and private higher secondary school students on achievement in science for rural male, rural female, urban male, urban female categories.

6. To find out contribution of scientific attitude and logical thinking on achievement in science of rural male, rural female, urban male, urban female students.

7. To find out contribution of scientific attitude and logical thinking on achievement in science of Govt. and private school students.

1.5 HYPOTHESES OF THE STUDY

Objective wise hypotheses were framed in null form as follows:

H01.1 There is no significant difference among high, moderate and low science achievers on scientific attitude of rural male higher secondary school students.

H01.2 There is no significant difference among high, moderate and low science achievers on scientific attitude of rural female higher secondary school students.

H01.3 There is no significant difference among high, moderate and low science achievers on scientific attitude of urban male higher secondary school students.

H01.4 There is no significant difference among high, moderate and low science achievers on scientific attitude of urban female higher secondary school students.
H0_2.1 There is no significant difference among high, moderate and low science achievers on logical thinking of rural male higher secondary school students.
H0_2.2 There is no significant difference among high, moderate and low science achievers on logical thinking of rural female higher secondary school students.
H0_2.3 There is no significant difference among high, moderate and low science achievers on logical thinking of urban male higher secondary school students.
H0_2.4 There is no significant difference among high, moderate and low science achievers on logical thinking of urban female higher secondary school students.
H0_3.1 There is no significant difference between male and female rural Government higher secondary school students on achievement in science.
H0_3.2 There is no significant difference between male and female urban Government higher secondary school students on achievement in science.
H0_3.3 There is no significant difference between male and female rural private higher secondary school students on achievement in science.
H0_3.4 There is no significant difference between male and female urban private higher secondary school students on achievement in science.
H0_4.1 There is no significant difference between rural and urban male Government higher secondary school students on achievement in science.
H0_4.2 To find out significant difference between rural and urban female Government higher secondary school students on achievement in science.
H0_4.3 There is no significant difference between rural and urban male private higher secondary school students on achievement in science.
H0_4.4 There is no significant difference between rural and urban female private higher secondary school students on achievement in science.
H0_5.1 There is no significant difference between Government and private rural male higher secondary school students on achievement in science.
H0_5.2 There is no significant difference between Government and private rural female higher secondary school students on achievement in science.
H0$_{5.3}$ There is no significant difference between Government and private urban male higher secondary school students on achievement in science.

H0$_{5.4}$ There is no significant difference between Government and private urban female higher secondary school students on achievement in science.

H0$_{6.1}$ There is no significant contribution of scientific attitude and logical thinking on achievement in science of rural male students.

H0$_{6.2}$ There is no significant contribution of scientific attitude and logical thinking on achievement in science of rural female students.

H0$_{6.2}$ There is no significant contribution of scientific attitude and logical thinking on achievement in science of urban male students.

H0$_{6.4}$ There is no significant contribution of scientific attitude and logical thinking on achievement in science of urban female students.

H0$_{7.1}$ There is no significant contribution of scientific attitude and logical thinking on achievement in science of Govt. school students.

H0$_{7.2}$ There is no significant contribution of scientific attitude and logical thinking on achievement in science of Private school students.

1.6 DELIMITATIONS OF THE STUDY

Researches in education are complex in nature. It is not possible for any researcher to consider problem as whole, if researcher includes various parameters, it will be difficult to conduct a research, analyze data, explain results and predict any events. Therefore, the delimitations of the study should be clearly stated. Due to limitation of time and financial assistance present study was delimited in following manner:

1. Only senior secondary students had been selected.
2. Students had been selected from Sangrur District (Punjab) only.
3. Govt. and private Senior Secondary Schools had been selected.
4. Only science students had been selected.
5. Only 400 students had been selected for final study.
6. One dependent variable (achievement in science subjects) and five independent variables (scientific attitude, logical thinking, sex, location and school types) had been selected for present study.

1.7 ASSUMPTIONS

In the present study it was assumed that:

a. Scientific Attitude Scale prepared by Shailaja Bhagwat (2006) is standardized tool and suitable for measuring scientific attitude of XII grade students.

b. Logical Thinking Test constructed and standardized by Sujeet Kumar and Shikha Tiwari (2012) is standardized tool and suitable for measuring Logical thinking of XII grade students.

c. Science Achievement Test constructed and standardized by R. D. Singh (2006) is suitable for measuring achievement in science of XII grade students.