IMPACT OF SELECTED AFFECTIVE VARIABLES ON ACHIEVEMENT IN SCIENCE OF SECONDARY SCHOOL STUDENTS IN AIZAWL DISTRICT OF MIZORAM

Thesis

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Doctor of Philosophy in Education

By

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Certificate

This is to certify that the thesis entitled ***"Impact of Selected Affective Variables on Achievement in Science of Secondary School Students in Aizawl District of Mizoram"*** submitted by Nitu Kaur, for the degree of Doctor of Philosophy in Education, of the Mizoram University, Aizawl, India, embodies the record of original investigations carried out by her under my supervision. She has been duly registered and the thesis presented is worthy of being considered for the award of Ph.D. degree. This research work has not been submitted for any degree to any other university.

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Month: December **Year: 2018**

DECLARATION

I, Nitu Kaur hereby declare that the subject matter of the thesis entitled 'Impact of Selected Affective Variables on Achievement in Science of Secondary School Students in Aizawl District of Mizoram' is the record of work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or, to the best of my knowledge to anybody else; and that the thesis has not been submitted by me for any research degree in any other University/ Institute.

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C E R T I F I C A T E

This is to certify that Ms. Nitu Kaur, a Ph.D. Scholar of the Department bearing registration No. MZU/Ph.D./809 of 9.11.2015 has worked on the thesis entitled '**Impact of Selected Affective Variables on Achievement in Science of Secondary School Students in Aizawl District of Mizoram'**. She has fulfilled all criteria prescribed by the UGC (Minimum Standard and Procedure governing Ph.D. Regulation). She has fulfilled the mandatory publication (publication enclosed). It is also certified that the scholar has been admitted in the department through an entrance test followed by an interview as per Clause 9 (i) and (ii) of the UGC Regulation 2009.

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ABBREVATIONS USED

16PF	16 Personality Factors
AAAS	American Association for Advancement of Science
AIIMS	All India Institute of Medical Sciences
APP	Advanced Placement Program
ATC	Achievement Test in Chemistry
Acd. Ach.	Academic Achievement
BARC	Bhabha Atomic Research Centre
CASA	Czerniak Assessment of Science Anxiety
CBSE	Central Board of Secondary Education
CMQ	Chemistry Motivation Questionnaire
CSIR	Council for Scientific and Industrial Research
DAE	Department of Atomic Energy
DIM	Dimension
DST	Department of Science and Technology
DV	Dependent Variable
ERCM	Education Reforms Commission Mizoram
ES	Emotional Stability
ESQ	Emotional Stability Questionnaire
ESS	Emotional Stability Scale
FFM	Five Factor Model
FFPI	Five Factor Personality Inventory
GHSGT	Georgia High School Graduation Test
HA	High Anxiety

HSLC	High School Leaving Certificate
HSPQ	High School Personality Questionnaire
HSSLC	Higher Secondary School Leaving Certificate
IEA	International Association for the Evaluation of Educational Achievement
IIT	Indian Institute of Technology
INSA	Indian National Science Academy
IQ	Intelligence Quotient
ISRO	Indian Space Research Organization
IV	Independent Variable
LA	Low Anxiety
M	Mean
MBSE	Mizoram Board of Secondary Education
MHRD	Ministry of Human Resource Development
MLL	Minimum Levels of Learning
NBHM	National Board of Higher Mathematics
NCERT	National Council of Educational Research and Training
NICE	National Institute for Health and Care Excellence
NOS	Nature of Science
OECD	Organization for Economic Co-operation and Development
PCB	Physics Chemistry Biology
PCM	Physics Chemistry Mathematics
PISA	Programme for International Student Assessment

RMSA	Rashtriya Madhyamik Shiksha Abhiyhan
SA	Science Anxiety
SAQ	Science Anxiety Questionnaire
SAT	Science Achievement Test
Sc. Ach.	Science Achievement
SD	Standard Deviation
SEK	Standard Error of Kurtosis
SEL	Social and Emotional Learning
SEM	Standard Error of Mean
SES	Standard Error of Skewness
SES	Socio-Economic Status
SM	Science Motivation
SMQ	Science Motivation Questionnaire
SMTSL	Students' Motivation Toward Science Learning
SPR	Scientific Policy Resolution
ST	Scientific Temper
STP	Scientific Temper Package
TAI	Test Anxiety Inventory
TIMSS	Trends in International Mathematics and Science Study
UNESCO	United Nations Educational, Scientific and Cultural Organization
X	Class 10

ABSTRACT AND STRUCTURE

The present thesis tried to centrally investigate the role of affective domain of learners in their science achievement. The study is based on research setting of Mizoram, a unique state in terms of cultural, ethnic and geographical milieu of our country where such phenomenon was not investigated in the past. The thesis comprises of five chapters. Chapter one builds up the conceptual framework of the study and offers a valid justification for the choice of the study. The chapter revolves around key research questions that led to the formulation of objectives and research hypotheses. Chapter two provides the review of related literature both in light of status of science education in the country as well as specifically with regard to review of studies in context of selected variables of the study. The next chapter brings in picture the methodological approach adopted for the study. Further the description of various tools and techniques used to collect the data is provided in chapter three. Chapter four analyzed and interpreted the sampled data with appropriate statistical techniques. The chapter focuses on different types of quantitative and qualitative analysis to derive a comprehensive meaning out of the collected data. Finally the last chapter incorporates all major findings followed by discussion on the investigated problem. The final chapter five also provides the educational implications of the present study that can have positive influence in improving the science achievement of students. Both general and specific recommendations are made based on what has been learnt from the findings of the study.

CHAPTER-1
CONCEPTUAL FRAMEWORK OF THE STUDY

CONCEPTUAL FRAMEWORK OF THE STUDY

"Affective area...will prove to be crucial in research and curriculum planning in the next decade" **John Head (1989)**

1.0 Introduction

The quality of human resource a nation produces matters. Worldwide natural resources are shrinking and the only resource a nation can vitally invest upon for a long term benefit is human resource. A scientifically trained manpower contributes directly to the progress of nation which is very true for all the developed nations of the world. It is a matter of fact that nations which heavily invest on the growth of science and technology are the one who are experiencing a high speed in the growth of their economy. Many of the Asian countries are doing well in this regard some of them being Japan, China, Korea, and Singapore. Half of nation's economic growth can be directly related to development of science be it agriculture, food security, health management, space research etc. In the last seventy years of post independence in spite of the entire infrastructure available for growth of science, our nation is still lagging behind when compared on world standards. It is a matter of great worry as much of our future's progress depends on the current status of science and technology.

1.1 Science and Society

Science education is the firm founding pillar for the development of any nation. This truth has been tested through time. Science together with technology and innovation has been universally recognized as one of the main driver of economic growth and societal well being (UNESCO, 2012). Science can play a critical role in uplifting the state of society and social equalization. Science has the power to free a nation from the clutches of poverty and despair provided the benefits of sciences are equally shared throughout the society. When science has to respond for the larger benefit of society, there is a need to inculcate scientific literacy to every member of society. The public understanding of science, the synonymous term for scientific literacy, is being relatively more focused upon by both the developed and developing nations in the dawn of 21^{st} century in order to meet the rapid increasing demand of scientific literate human resource. It is more important to have a society with scientific bend of mind than being a nation having a celebrated scientific community which could share their research findings in limited scientific circles. Hobson (2008) highlights the need of scientific literacy by saying that industrialized democracies cannot survive unless their citizens are scientifically literate. Liu (2009) states that it never happened before the new times of late 20^{th} and beginning of 21^{st} century, that a nation's economic development became totally dependent on advances in science and technology alone and this resulted in creating demand for technical workers and a scientifically literate populace. On the contrary to this requirement of nations, scientific knowledge does not find an easy interpretation with everyone with same ease, the reason being its' abstractness. According to Ridder (2014), science is a highly specialized and complex endeavor and its inner workings are virtually inaccessible to lay audiences. Scientific

literacy is all about making science assessable, understandable, implementable and usable for lay person. A layman can definitely use his/her imagination to ponder upon his existence without the wonders of science and think for a while how his life will be affected by the absence of electricity, medicines, means of transportation, tele-communication, virtual world and all other gifts of science. The layman would certainly realize that life would be miserable without the wonders of science but may not bother much beyond this. However, a scientifically literate person will react with a different frame of mind by appreciating and relating the value and importance of science in their lives. He/she follows a scientific approach in every kind of problem solving in their daily lives. 21st century is in serious need of such scientific literate world citizens who can contribute significantly for the development and betterment of human civilization. All nations can significantly increase their adult scientific literacy by requiring non-science college students to take two or three science literacy courses (Hobson, 2008). Science education thus becomes not only an essential but compulsory feature of any educational program. One of the most important aims of science is education in modern times. Science has to reach to one and all through education. This sets stage for interdependence of science and education. Whereas the benefits of science cannot be reaped by all in lack of education, at the same time education without science holds no linkage to life. This would then reflect in ultimate goal of achieving an adequate level of scientific literacy required to boost up the nation building process as stated by The American Association for the Advancement of Science (AAAS), in the following words,

"*Scientific literacy, which encompasses mathematics and technology as well as the natural and social sciences, has many facets. These include being familiar with the natural world and respecting its unity; being aware of some of the important ways in which mathematics, technology, and the sciences depend upon one another; having a capacity for scientific ways of thinking; knowing that science, mathematics, and technology are human enterprises and knowing what that implies about their strengths and limitations; and being able to use scientific knowledge and ways of thinking for personal and social purposes. Thus scientific, mathematical, and technological processes are important factors in improving society, along with thinking skills and scientific knowledge."*(1989, p. 20).

With regard to the above notions on scientific literacy it is felt that mathematics, science and technology based education in any country holds the key for the uprising of the society. The two key subjects in the school curriculum namely the mathematics and the sciences very much predicts the future outcomes of the learners in this competitive and technology based age, no matter which stream of higher education one takes up. A strong mathematics and science background in high school is essential for future educational and occupational opportunities (Alper, 1993; National Council of Teachers of Mathematics, USA, 2000). Basic understanding of these two subjects always compliment to their success in any desired field of profession. The present research study has its background in science education. Science education is the most required education for students as it satisfies their natural tendency of curious observation and questioning. They learn about their surroundings through science which unfolds the nature to them and enable them to

understand the laws of nature. The environment in which a person stays generates many stimuli against which the learner presents the response. The cause and effect mechanism is very essence of understanding science. Science has more to do with the attitude borne by the students of science than their knowledge expedition. It is important to generate knowledge but it is more important to establish valid means of knowledge generation. Science education is spaced central to any curricular experiences as it holds linkage to allied disciplines like mathematics or social sciences. So to develop the zeal amongst the students to enjoy and live scientific experiences a lot of efforts are required at various levels of institutions right from family through society to nation. In fact science education can never be improved in our country if interest for science at the level of every young mind is not kindled. It is very important to encourage science learning from early elementary years of education. If ability to think scientifically is nurtured in elementary years it can have far lasting impact in the advance years of science learning. Traditional elementary science teaching, especially in our country do not extend beyond knowledge and understanding levels in terminologies and concepts of science and a serious lacking is seen throughout these years on the application of science. Therefore there is a need to bring in the culture of practical applications and demonstrations of scientific principles and laws right through the early years. Science can be taught through amusement and fun, nature walks, observation of exhibits of nature and developing an understanding of nature of science (NOS). There are three domains of science to be explored inside and outside science classroom experiences, namely the body of knowledge, a set of methods/processes and a way of knowing (Bell, 2009). The first domain refers to the huge, dynamic and ever expanding body of knowledge which can be only glimpsed and showcased in limitations of school science. The second domain indicates the importance of practical experiences, the laboratory culture of school science wherein students learns methodology of doing science. Finally the third domain relates to the NOS which is still an unfamiliar and alien domain in Indian scenario. Often it is misunderstood by the teachers and mis-communicated to the students leading to conceptual stigmas. This domain of science is poorly addressed in majority of curricular materials, and when it is addressed it is misrepresented (Bell, 2009). The nature of science is a multifaceted concept that defies simple definition which includes aspects of history, sociology and philosophy of science and has variously been defined as science epistemology, the characteristic of scientific knowledge and science as a way of knowing (Bell, 2009). The nature of science in its real essence value teaches the student to inculcate some basic process skills like observing, measuring, inferring, comparing, theorizing, predicting, communicating, modeling, experimenting, controlling variables etc. Much of this is also a basic requirement for a scientific literate person. These skills of basic science process enable a person to comprehend, analyze and judge situations where science is involved in day to day affairs like purchasing a new product from grocery store or reading a science article on a new discovery.

1.2 Science in context of India

The history of science education in India trace back to pre-independent era of colonial times. There are few names in the pre independent India which were like the founding stones of modern science

in India. They are the one who dedicated their whole life in the pursuit of scientific knowledge. Nobel laureate, a great physicist, C.V. Raman; and other great physicists Satyendra Nath Bose; J.C. Bose; Vikram Ambalal Sarabhai; S.K. Mitra; Meghnad Saha; Homi J. Bhabha; a great chemical physicist, S.S. Bhatnagar; a great chemist, Prafulla Chandra Ray; a great statistician, P.C. Mahalanobis, great botanists, Birbal Sahni & S.R. Kashyap, a great mathematician, S.Ramanujan, a great geologist, D.N.Wadia, were some of those pioneer people who contributed for the advent of science in India under the British regime (Indian National Science Academy, 2001). With the dawn of independence India experienced the eclectic feeling of pride of past glories and the visionary leaders tried in all ways to make things in order for a new beginning. Sir Homi Jahangir Bhabha while addressing the general assembly of International Council of Scientific Unions said that the difference between the developed and developing nation lays in the fact that later lacks modern science and an economy based on modern technology (Indian National Science Academy, 2001). It was an advantage for post-independent India to have Jawaharlal Nehru as her first prime minister. He held the notion that the development of the nation lies in the minds of the citizen and unless and until the minds of the people are enlightened the nation cannot progress. The Council for Scientific and Industrial Research (CSIR), initially at Calcutta, founded by Sir S.S. Bhatnagar and The Bhabha Atomic Research Centre (BARC), Bombay, founded by Sir Homi Jahangir Bhabha in the pre-independent India, became full fledged functional after the initiative taken by Nehru. Soon, The Indian Institute of Technology (IIT) first in Kharagpur (1951), followed by Bombay(1958), Madras (1959), Kanpur (1959), Delhi (1963) and parallel to it, the All India Institute of Medical Sciences (AIIMS), Delhi (1956) came into existence to accelerate the rate of research & development and improve the quality of life in India. After the initiative taken by Nehru, the national Scientific Policy Resolution (SPR) was passed by Indian parliament in 1958 which promised to prioritize the growth and development of science and technology for ensuring the nations' welfare. In the post independent era the development of independent scientific endeavour already set to happen but the progress and pace is not very pleasing. The journey since independence is a pretty slow until recently, in September, 2014 when the successful insertion of robotic spacecraft, the 'Mangalyaan' in the planet mars orbit after a year of its launch by Indian Space Research Organization (ISRO) created history. By this successful attempt India became the first nation in world to launch interplanetary mission spacecraft into mars in its first attempt. So far this is the most internationally acclaimed event in the history of science in India. It is an impressive victory of India in the arena of space science. India made a relatively late beginning but definitely managed to have impressive lasting effect in the field of sciences. But still there are barely a handful of people in the country known for their contribution towards science. The state of research in sciences is in not at par with the international standards and the magnitude of research outcome is far beyond comparisons with the leading nations of the world. Slowly and steadily a lot has been done and much more awaits to be achieved. May be this is just a beginning for a nation after seventy years of independence. India's efforts in field of science and technology will surely glorify in years to come if importance of science is addressed through school curriculum.

1.3Affect and Science

It's a common assumption that facts are food for brain and fuel the thinking process and especially in context of teaching-learning process of science subject facts play exclusive role. Inside a science classroom facts float and pour into the minds of learner and much of this business is controlled by the science teachers. Are facts enough to develop the learner's potential in science? Why most students find science learning difficult as they proceed to higher grades? One must wonder if there are some missing ingredients in current school science recipes in order to address the declining interest of students towards higher sciences. Teachers traditionally targets the cognitive domain of learner and the affective domain of learner most of the time does not find a space in science classrooms. The word affective refers to the learners' affect such as emotions, feelings, moods and attitudes involved in teaching learning process. Affective domain of the learner has been neglected for long in the field of science education. It is a strong assumption that science demands less dependence on one's affect and more on one's cognition. Science became a discipline of high grade owing to a renaissance of scientific revolution not older than four centuries. Within such a small span of time the greatest of human achievements have been sought. This age also brought in some dominating thought processes. The western thought advocates a strong assumption that emotions threaten the disembodied, detached, and neutral knower hence they do not offer any valid knowledge which undermines the importance of emotions (Zembylas, 2005). This thought process thus clearly mentions that science has little to do with feelings and a scientist, the so called neutral knower has to shed away any biases for holding a proposition and it is a serious requirement of one's detachment from one's own self. School science is being portrayed as rational and non-emotional (Alsop, 2001; Zembylas, 2002). It all started through modern version of school science which misinterprets the real nature of science (Bell, 2009). Science education has been victim to episodic transitions of industrialization, material world and urban settlements which could have not succeeded in absence of school science. Science education in modern times has given rise to certain phobias which are actually not defining the real nature of science. Why is it so that affect has been consistently a neglected arena in context of science education? Is science free from emotions? Is being rational equivalent to being emotionless? Science has been treated largely as a cognitive affair until recently when the connection between science and learner's affective domain has been reported in literature. Science education is not limited to cognition rather it becomes more meaningful when it targets the affect of the learners (Alsop & Watts, 2003).Valiente et al., 2012 suggests that emotions matter to a range of development outcomes. Further quoting Izard, 2002 they concluded that however, research has neglected when and why emotions are associated with academic success, even though "*emotions contain useful information that can guide cognition and action*".

The affective component in science education has been an untapped area which needs a beginning. The benefits of affect in science can be hired by establishing connections between the three domains of science as described by Bell (2009) as the body of knowledge, methods of doing and ways of knowing. The possibility of exploring the affective component is maximum in relating science teaching and learning with nature of science (NOS), highlighted in the third domain. This is solely

the responsibility of science teachers and educators who need to redefine pedagogical approaches for the same. Abrahams (2009) suggest that research indicate that there is affective component in doing science. His finding suggest that the second domain of science as described by Bell (2009) namely the 'doing science' or the 'practical' component has inter-linkage with affect as well.

Nurturing of key affective traits should be the prime focus of 21st science education because of the potential they possess to contribute for the benefit of science and larger society. Our actions are guided by our emotions and there is some possible connection between affect and science. Science demands faith on its dynamic nature by doers of science and root of this faith lies in the passionate labor they put in their scientific endeavor which is never possible without involving one's emotions. Actually, affect is the artist behind the artistry of science.

1.4 Science and Scientific Temper

The post independent India under the leadership of its first Prime Minister Jawaharlal Nehru got a firm footing in the sphere of Science and Technology. The Nehruvian vision was to develop the nation by rejuvenating it through the spirit of 'Scientific Temper', a term coined by him in his book 'Discovery of India' (1946). He wrote in his book that although science has been dominating in the western world, west is still far from having developed the real temper of science whereas India, in spite of her less triumph in the sciences, has the advantage of traditions encouraging fearless search for truth, respecting the solidarity of man, the divinity of everything living, free and co-operative development of the individual and the species, ever to greater freedom and higher stages of human growth (Nehru, 1946, pp.514-516). His conclusion was a direct outcome of two world wars fought in the recent past that ashamed humanity. It was a timely plea to the world leaders, politicians, scientists, citizens of the times to identify the much needed notion of 'scientific temper'. He emphasized that the trait of scientific temper is to be possessed by every citizen of the country and credit goes to him for establishing pioneering institutes in country for the development of science and technology soon after India gained freedom. Nehru is claimed to be the architect of modern India, who knew the importance of science and technology through his first-hand experience during his stay in Europe. He set the stage for Indian expedition in the world of science by emphasizing on building a new awakened nation free from superstitious belief systems and prejudices borne by the people of land leading to their miseries. He started a tradition of bringing reforms in the society through inquiry based judgements. In fact, India included 'scientific temper' in her constitution through 42nd constitutional amendment, 1976. It was introduced as a sub clause of article 51-A (h) of Indian constitution 1949, as one of the fundamental duties to be performed by Indian citizens which states, '*to develop the scientific temper, humanism and the spirit of inquiry and reform'.*

After the death of Nehru, the legacy of scientific temper was taken forth by the Nehru centre, Bombay which has been organizing Nehru memorial lecture series since 1966. After being framed as a fundamental duty of Indian citizen, the notion of scientific temper again came in lime light when some group of people, mainly from the academia July 1981 at Nehru centre in Bombay issued an historical statement on scientific temper. This historical event invited a lot of debate all over the country and since then a lot of thinking has been again poured into this forgotten notion.

To begin with tracing out the term temperament it is found that it is distinctly associated with G.W. Allport, who is regarded as the founder of personality psychology.

Temperament refers to the characteristic phenomena of an individual's emotional nature, including his susceptibility to emotional stimulation, his customary strength and speed of response, the quality of his prevailing mood and all the peculiarities of fluctuation and intensity of mood, these phenomena being regarded as dependent upon constitutional make-up and therefore largely hereditary in origin. (Allport, 1961, p. 34).

Goldsmith and Campos (1986) defines 'temperament as individual differences in emotionality'.

McCrae et.al (2000) states that there is no hard and fast distinction between temperament and personality and there are both empirical and conceptual links between child temperaments and adult personality traits. Review of literature suggests that the term temperament and personality are used interchangeably (Strelau, 1987).

It is evident from the above definitions that temperament is an affective construct which deals with emotionality and has a direct or indirect linkage to one's personality. It could be a possible reason for Nehru to pick the term 'temper' from the psychological construct of 'temperament'. Nehru associated temper with science synthesizing a typical trait associated with science and being a scientist. It is a required commitment and inclination within a doer of science in order to understand and apply science in both academic and societal level.

A Statement on Scientific Temper" prepared by a group of scholars and issued on behalf of the Nehru Centre, Bombay, in July 1981, mentions that Scientific Temper involves the acceptance, amongst others, of the following premises: (a) that the method of science provides a viable method of acquiring knowledge; (b) that the human problems can be understood and solved in terms of knowledge gained through the application of the method of science; (c) that the fullest use of the method of science in everyday life and in every aspect of human endeavour from ethics to politics and economics is essential for ensuring human survival and progress; and (d) that one should accept knowledge gained through the application of the method of science as the closest approximation of truth at that time and question what is incompatible with such knowledge; and (e) that one should from time to time re-examine the basic foundations of contemporary knowledge.

This notion was also mentioned for the in the fourth survey of education, 1991 in the chapter on science education which was edited by Ganguli and Vashistha. It states *"Science education is supposed to perform a two –fold task. The prime objective, in individualistic perspective, is the cultivation of scientific temper, which includes a spirit of enquiry, a disposition to reason logically and dispassionately, a habit of judging beliefs and opinions on available evidence, readiness to reject unfounded theories and principles, the courage to admit facts, howsoever, unsettling and disagreeable they might be and, finally, recognizing the limits of reasoning power itself. It is also expected of science education that it would give individuals a firm grasp of concepts and processes of science and impart to them the ability to use scientific method of problem solving and techniques of observation and experimentation in handling problem of comprehension or life. At the societal level one of the major objectives of science education is to equip individuals to participate in creation of a society which is free from poverty, hunger, disease and evils such as violation, exploitation, oppression etc."*

Narlikar (1993) emphasized that scientific temper is the real need of the hour which guides man to rational recourses whenever there is conflict between science and tradition. One neither has to be dazzled by miracles of science nor blinded by overpowering traditions. Scientific temper is that self-

correcting tendency of rational beings that helps him/her to harmonize between needs and desires. He said there are three fundamental processes operating in science which are Experiment (E), Observation (O) and Deduction (D) that keeps science going and scientifically tempered person believes in the EOD system of testing and verifying knowledge.

According to Dhar (2009), scientific temper, or scientific attitude is characterized by following traits: a)Healthy scepticism, b)Universalism, c)Freedom from prejudice or bias, d) Objectivity, e)Open mindedness and humility, f) Willingness to suspend judgement without sufficient evidence, g) Rationality, h)Perseverance - positive approach to failure.

Chacko (2011) presented a critical analysis of Indian nuclear discourse. The author tries to identify the relationship between India's nuclear programme and its post colonial identity. India's deep rooted commitment for modernity with ethics can be related to the so called scientific temper of Indian civilization which was badly devastated in colonial times and eventually leading to anti-colonial discourses. This resulted into an ambivalent nuclear behaviour of India where on one hand nuclear disarmament treaty was signed by her and on other hand circumstantially her failure to sign non-proliferation test ban treaty. The author gives a defence for her nuclear policy in the light of political diplomacy.

Hak-Soo Kim (2012) emphasized scientific temper as a behaviour that brings to science open-mindedness and free will. Scientific temper needs to be redefined as advocated by 'Nehru' battling against pseudo sciences like religious bigotry and superstitions. This can be done by contextualizing scientific temper with engagement with problems and striving to find its solution.

Mahanti (2013) gives a historical tracing of the concept of scientific temper in our country. He reported that although the termed was coined and used for the first time by our first Prime Minister Pt. Jawaharlal Nehru, the existence of the notion can be traced back to Gautama Buddha in Indian traditions and to social reformers like Raja Rammohun Roy, Rajendralal Mitra and Prafulla Chandra Ray. He also reports that it was our first prime minister who greatly contributed for upholding of this nation under which country's development could gain a momentum. Nehru's effort led to the adoption of Scientific Policy Resolution (SPR) of 1958 by Indian parliament which prioritized the growth of science and technology. In 1981 some group of intellectuals, scientists, educationists and thinkers tried to begin a fresh discussion on scientific temper at the national level. The most recent event in revitalizing this Indian notion was the Palampur declaration of 2011 which was an attempt to revisit the 1981 statement of scientific temper.

Arseculeratne (2014)tried to perform comparison between western and eastern notions of scientific attitude (temper) through historical analysis and concluded that the former finds it origin in secularism, concreteness and objectivity whereas the later originates from religion, abstractness and subjectivity.

Gopichandran (2013) tried to emphasize on the need of the hour for nation, especially in context of launch of 12th five year plan, i.e. to instil the trait of scientific temper both in masses and educational institutions. He further said that students at all levels of learning including higher education and research should be oriented to principles of science and scientific thinking, wherein such aspects as open-endedness of insights, heuristics, and emerging frontiers of knowledge based on newer and better application of tools/techniques and limits and limitations of systems of investigations and insights are suitably highlighted. It is equally important to infuse human values such as respect for knowledge systems and the spread and depth of knowledge consolidation in a way that reveal the founding principles, precautionary principles and common good.

Saxena (2014) tried to pinpoint the misconception about scientific temperament (temper) within the layman because of ignorance. He suggests that educating the young in order to imbibe in them an argumentative approach to test and accept things is perhaps the only way to develop scientific temper in society.

Kumar et al. (2014) states that scientific temperament as an attitude of mind that leads to the inculcation of practices to use ways and methods of science in every sphere of one's life. In fact, it becomes more important in dealing with the non-scientific issues in the society.

Raza (2015)tried to compare the hazy or nebulous notion of scientific temper with the European enlightenment.He argued that scientific temper not only confines itself with areas of human cognition and action but it goes beyond the boundaries of science and extents in the realms of extra-science as well. The struggle of creating a scientifically tempered society is a collective endeavour to be strived by one and all and scientific awareness is the prerequisite for it. He cited evidence where increase in scientific information in society does not guarantees the reduction of extra-scientific beliefs. Both tend to coexist with their contrasts as long as they are not in the way of each other which are a very doubtful situation for scientific temper.

In western literature the term 'scientific temper' is not as popular but an analogous term 'scientific attitude' existed much before the former terminology.

The psychological construct of 'attitude' has been best defined by Thurstone (1929) "the sum total of man's inclination and feelings-prejudices and biases, preconceived notions, ideas, fears, threats and convictions about any specific topics. "

Further Allport (1935) defines it as "An attitude is a mental and neural state of readiness organized through experience, exerting a directive and dynamic influence upon the individuals' response to all objects and situations with which it is related."

As far as term scientific attitude is concerned it has been readily studied since early 20^{th} century.

Davis (1935) tried to philosophize three key purposes of science namely, a scientific attitude, a scientific method and a fund of information which enables a scientist to repeat what has been tried before. Further scientific attitude was measured in terms of student's traits of 'willingness to change opinion on the basis of evidence', 'search for the whole truth without prejudice', and 'the habit of basing judgment on fact'.

Merton (1942) formulated four sets of institutional goals for science which are universalism, communism, disinterestedness, organized skepticism which together define the ethos of modern science. His description is very much in harmony with the concept of scientific temper.

According to Indian Education commission (1964-66) "The curriculum at the secondary stage should meet the needs of the adolescent as well as the needs of the democratic society in which he is expected to participate as a citizen on reaching maturity. The needs of democratic citizenship will require the development of certain skills, attitudes and qualifies of character such as the capacity for clear thinking, the ability to communicate easily with one's fellowmen, the scientific attitude of mind, sense of true patriotism and an appreciation of the value of productive work."

According to Moore & Sutman (1970) science attitude is the opinion or position taken with respect to a psychological object in the field of science. They used this definition in constructing and validating the 'inventory of scientific attitudes' named as Scientific Attitude Inventory (SAI), a very popularly used instrument for the assessment of scientific attitude.

Klopfer (1971) categorized some behavioural attributes identified as affective behaviours in science education and mentioned the manifestation of favourable attitudes towards science and scientists and acquiring the trait of scientific attitude as some of the fundamental behaviours.
Gardner (1975) distinguished between 'scientific attitudes' and 'attitudes towards science'. It was explained that the former is a complex combination of cognitive parameters within an individual that keep him/her compelling to weigh the evidences before accepting the facts, ask questions, have an urge to know and understand and always guides one decision, whereas the later is very much affective in origin that decides one's feeling, belief and value complex towards science, scientists and science related affairs.
Osborne, Simon, & Collins (2003) did an extensive review of literature on 'attitudes towards science' and concluded that it is not a unitary construct but is comprised of various sub-constructs owing to its affective nature and one of the major stumbling block in for various researchers was its measurement. There are various underlying factors that play a role in deciding one's attitude towards science which are the perceptions of important others like science teachers, peers and friends; anxiety toward science; the value of science; self- esteem at science; motivation towards science; interest and enjoyment of science; attitudes towards science; attitudes of parents towards science; the nature of the classroom environment; achievement in science; and fear of failure on course.
The conclusion of all the above definition can be taken that scientific temper and scientific attitude can be taken as overlapping psychological construct where former is more reflected in ones' outlook towards environment through his/her actions and behavior and the latter is shaped in situations and contexts related to understanding and doing sciences. Each construct is a complex whole of several related sub concepts.

1.5 Science and Science Motivation

Motivation is a psychological construct which is associated with complying with certain set of needs of a being. In context of educational psychology it is widely studied as need of achievement (n-Ach) also referred as achievement motivation. It has an association with narrow band personality theories (Peck & Whitlow, 1975).
Atkinson & Feather (1966) developed the n-Ach theory and regarded n-ach as a motive which in combination with other variables can predict of one's behavior in a variety of setting. They found that the three important factors bearing upon one's success are i) one's degree of achievement motivation, ii) one's fear of failure and iii) the incentive or the value of the accomplishment to the individual.
n-Ach is concerned with accomplishment, and how people vary in the degree that they are prepared to strive towards succeeding in competition at a particular standard of excellence (Peck & Whitlow, 1975).
Pajares & Schunk (2001)found that students who are encouraged by parents favorably to explore and try different activities are found to be higher on their self-efficacy levels and are motivated to perform better academically. Favorable school environment and positive peer support are found to contribute equally to their self-efficacy level and they reflect positive behaviors such as improved

class attendance and class participation, asking questions and seeking advice and participating in study groups.

Brophy (2004) defines student motivation as "the degree to which students invest attention and effort. In general, motivation is the internal state that arouses, directs, and sustains goal-oriented behavior. In particular, motivation to learn refers to the disposition of students to find academic activities relevant and worthwhile; and to try to derive the intended benefits from them."

Glynn, Aultman & Owens (2005) defined motivation in general as an internal state that arouses, directs, and sustains goal-oriented behavior. They further highlighted through their literature review that researches in past have been trying to employ various motivational construct in teaching learning contexts in order to motivate students to learn and it is hard to predict which of these constructs holds the best explanatory power. They categorized the reviewed construct mainly belonging to three categories, i) firstly, the constructs referring to students' traits and states, such as activity and anxiety level, interest, and curiosity together falling together in studies on comparison between intrinsic and extrinsic motivation to learn; ii) secondly the constructs related to students' beliefs, such as self-determination, goal orientation, self-regulation, and self- efficacy; iii) and lastly constructs that refer to students' responses to others' expectations such as instructors, advisors and administrators.

Betoret, Rosello & Gomez-Artiga (2017) suggested through their findings that expectancy-value beliefs of students which included their achievement expectations, value of the subject matter, process expectations with the teacher, expected cost to pass the subject are capable of satisfactorily explaining and predicting student achievement and their degree of satisfaction with the teaching process followed with a specific subject matter.

Studies exclusively focusing on science motivation started with efforts of Glynn and Koballa (2006) when they tried to develop an instrument named students' motivation towards science. It is believed that high science motivation levels within students seem to one of the vital indicators of high achievement in science. They developed a Science Motivation Questionnaire (SMQ) to measure students' motivation to learn science in college or high school courses using a 30-item Science Motivation Questionnaire to assess six components of students' motivation. These components are intrinsically motivated science learning, extrinsically motivated science learning, relevance of learning science to personal goals, responsibility (self-determination) for learning science, confidence (self-efficacy) in learning science, & anxiety about science assessment. The test has been found to reliable and valid. After this study several other studies came up trying to measure science motivation level in varied samples of population.

Glynn,S.M., Taasoobshirazi, G. &Brickman,P.(2009) in their study science motivation stated that"in studying the motivation to learn science, researchers examine why students strive to learn science, how intensively they strive and what beliefs, feelings, and emotions characterize them in this process."

Glynn, Taasoobshirazi, & Brickman (2009) tried to examine the motivation to learn science of non-science majors enrolled in a core-curriculum science course using Science Motivation Questionnaire, 30-item Likert-type instrument. An exploratory factor analysis suggested that the

questionnaire has construct validity and the students conceptualized their motivation to learn science in terms of five dimensions: intrinsic motivation and personal relevance, self-efficacy and assessment anxiety, self-determination, career motivation, and grade motivation.

Glynn et al. (2011)tried to measure the science motivation by developing Science Motivation Questionnaire II (SMQ II) of science majors and non-science majors in American undergraduate students in order to assess the differences in the motivation to learn sciences, if it exists at all. Discipline specific versions are also available as Biology Motivation Questionnaire II (BMQII), Chemistry Motivation Questionnaire II (CMQ-II), and Physics Motivation Questionnaire II (PMQ-II) in which the words biology, chemistry, and physics are respectively substituted for the word science. The SMQ II assessed five motivation components: intrinsic motivation, self-determination, self-efficacy, career motivation, and grade motivation. They used the perspectives of social cognitive theory of Bandura highlighting the importance of environmental factors in human functioning. It was reported that the science majors were better on all the components of science motivation and in both science majors and nonscience majors, men had higher self-efficacy than women, and women had higher self-determination than men. This suggested that science motivation differs with the background i.e., their preference to choose science as major or non-major subject at undergraduate level. The study confirmed that SMQ II is a useful tool to determine science motivation of college students.

Salta & Koulougliotis (2015)tried to adapt Science Motivation Questionnaire II (SMQ II and made the Greek version of Chemistry Motivation Questionnaire II (Greek CMQ II) to investigate Greek secondary school students' motivation to learn chemistry for the first time. 330 secondary students (163 boys and 167 girls) belonging to lower (14-15 years) and higher secondary schools (16-17 years) were chosen for the study. Confirmatory analyses proved the Greek version to be reliable and valid. Gender based comparisons showed that girls had higher self-determination than boys in both the age groups and also the girls of lower secondary groups had higher career and intrinsic motivation than the boys of the same age group.

Science motivational studies are relatively new arena in the field of science education and are of far-fetching value in terms of improving the motivational constructs applicable in science teaching – learning processes.

1.6 Science and Science Anxiety

Mallow (2010) defines the term "science anxiety" as a debilitating interaction of emotion—fear, with cognition—science learning which often manifests itself as a crippling panic on examinations in science classes, but it is distinct from general test/ performance anxiety. He coined the term in 1977, when he identified and defined the phenomenon observed within the clientele at Loyola University Counseling Center, Chicago, the first clinic of its kind to address the phenomenon.

There are traditionally many studies related to general test anxiety in teaching learning contexts both in the field of education and psychology.According to Pekrun et al. (2002) academic emotions have largely been neglected by educational psychology, with the exception of test anxiety.

Anxiety in general is treated as an unwanted trait that disturbs the emotional equilibrium and interferes with students' performance in schools. It is one of most common psychological feeling when someone encounters unfavourable situations like tests, competitions, teachers' expectations, failure in examinations and other related situations. Studies in past have been reporting that anxiety as an emotional state is negatively associated with students' achievement levels. In spite of one's general desire to be less anxious facing various situational circumstances, it's a fact that anxiety is a very obvious phenomenon. Whereas on one hand it is assumed that science anxiety is one of the causes for students' underachievement in science, on the other hand students' underachievement in science can be the cause for science anxiety.

However, some parallel researches have reported anxiety is not harmful in all situations because of its biological and psychological origin. It is reported that a moderate level of anxiety is good, in fact, in that it helps motivate learning (Cassady & Johnson, 2002). They tried to review past researches on test anxiety and found assessments in past had two major dimensions which are, i) the Emotionality dimension measured as physiologically manifested responses experienced during evaluative situations like (a) increased galvanic skin response and heart rate, (b) dizziness, (c) nausea, or (d) feelings of panic; and ii) Cognitive test anxiety measured in terms of individuals' cognitive reactions to evaluative situations, or internal dialogue regarding evaluative situations, in the times prior to, during, and after evaluative tasks.

It can be concluded that anxiety as a psychological construct is overlapping between cognitive and affective domains of individual.

It was Mallow in 1977, who put forth the concept of 'Science Anxiety' as mentioned before. Since then many studies have been reported by Mallow and others on the construct of science anxiety.

Mallow (1981)defined science anxiety as a fear or aversion toward science concepts, scientists, and science-related activities.

Mallow & Greenburg (1983) define science anxiety as "a diffuse or vague fear which arises in response to the prospect of learning science and results from intervening self-messages rather than from the science learning itself".

Many a times the environment in science classroom is not favourable for every kind of learner such as slow, introvert, depressed, sad learners. While experiencing science instruction often the under achievers associate their present learning situations with past unpleasant experiences of science classroom. The emotionally disturbed state of learner may be an outcome of their unfavourable classroom experiences caused due to various reasons such as insensitivity of teachers, overloading of science concepts, inadequate integration of topics, abstract mode of science teaching, strictness of the teachers and school authority. This leads to science anxiety. Science anxiety is a prevalent phenomenon being experienced by the learners across the science classrooms belonging to different cultural, ethnic and national settings. It is one of the prime areas under a wide scale investigation worldwide. It is one of indicators for under achievement in science. Although a lot of research has been conducted in the field of test anxiety, a few researches have been found to explore the level of anxiety felt by the students for the science subject. Hence the importance of this variable cannot be neglected.

According to a latest reporting by Kastrup & Mallow (2016) students bring to the classrooms preconceived attitudes, as well as the emotional baggage called 'science anxiety' and may regard science as cold, unfriendly, and even inherently hostile and biased against women. Further they report that, the causes of science anxiety are many, including past bad experiences in science

classes, science-anxious teachers in elementary and secondary schools, a lack of role models, gender and racial stereotyping of scientists in the popular media.

However, there is difference between fear and anxiety. Fear deals with things which are generally phobic for majority like arachnophobia, fear of spiders; hydrophobia, fear of water whereas anxiety on the other hand is a fear of something self contained within a person who feels anxious upon facing a situation, a person or a consequence. It is fearful for some and absolutely not for others. It means anxiety is varying phenomenon. Some people may be highly anxious, some moderately anxious and some may not be anxious at all for an existing situation or entity. Kastrup & Mallow (2016) explains this through a beautiful example,

"*Fear deals with things of which there are good reason to be afraid, such as a viper in your bed. Anxiety on the other hand means being scared of something that is not intrinsically fearful. Science anxiety is not a viper in your bed. But to a science-anxious person, it feels like it."*

Thus it can be concluded that anxiety can be misunderstood to be a fear in many instances although it is just one of the psychological manifestation of anxiety.

Chiarelott & Czerniak (1984) found that children as early as third grade, exhibit anxiety toward science and females, as early as third grade, exhibit more anxiety than their male counterparts. They found in their research that (a) science anxiety was correlated with science achievement; (b) science anxiety was gender-related; (c) science anxiety emerged early in a student's exposure to science curriculum ; (d) elementary teachers felt generally unprepared to teach science, and (e) teachers' attitudes correlated with their science anxiety.

Yurkewicz (1988) examined the relationships among science anxiety, success in science, and teacher behaviors such as expectation clarity, elitism, and instructional difficulty in 1622 science students from 86 secondary classes and he found that student perceptions of teacher behaviours were related to pupil science anxiety.

Wynstra & Cumming (1990)tried to identify the relationship of science anxiety with achievement, test anxiety, year of chemistry and gender. They also attempted to establish the reliability of Czerniak Assessment of Science Anxiety (CASA) by L. Chiarelott and C. Czerniak (1987). 101 students (45 males and 56 females) in grades 10 through 12 in chemistry classes from public high school in Rockford ((Illinois) were selected for the purpose. 61 students were from first and 40 students from second year chemistry class. Correlations were measured between the CASA and the first chapter test; CASA and the quarter grade; CASA and Test Anxiety Inventory (TAI). There was a significant correlation between the CASA and emotionality subscale of TAI but no correlation with the worry subscale. The first year students scored higher than the second year and female scored significantly higher than males on CASA. The study supported the reliability of the CASA.

Udo, Ramsey, Reynolds-Alpert, & Mallow (2001) further established that science anxiety is a debilitating interaction of emotions (fear) and cognition (science learning) because there is a correlation between students' feelings and their ability to understand the subject matter.

Kastrup & Mallow (2016*)* in their bi-national study on Danish and American students found that females in the non-science groups had significantly higher anxiety than males. However, students irrespective of gender or field of study expressed strong negative attitude towards science. Their study raised many questions on contemporary practices of imparting and doing science which leads to science anxiety. Their submission is to turn the table using a learner friendly approach, where learners are constructing science experience in multiple perspectives.

Science anxiety has been reported in west as one of the factors responsible for decrease in enrolment of students in science subject at higher levels. Science anxiety is a gendered phenomenon which is supported by many of the studies.

Kastrup & Mallow (2016) reported that while the proportion of college females and males majoring in biology or chemistry is about fifty-fifty, physics is still very gender bifurcated wherein only about 20% of physics majors in the US are female, and the problem of gendered- subject preferences is international. According to Alper(1993) the gender preferences in relation to sciences are cultural and not biological that points women and men in different directions. Both the genders receive different societal signals right from their childhood and are perhaps moulded differently about their abilities and expectations. It further intensifies the plot of psychological gender differences.

Handley & Morse (1984) revealed that women report less positive attitudes toward science than do men students.

Yager & Yager (1985) found negative attitudes of students toward science increase by grade level and students' interest in science starts declining between third and seventh grade.

Matyas (1985) found that problem of negative attitude toward science is more in women. Fewer women are enrolled in science classes than men.

Kaya & Yildirim (2014) investigated the sources of student's science anxiety failing in chemistry subject and found that science anxiety resulted from unpleasant classroom activities, fear of test, perceptions of chemistry, teacher attitudes, and parent attitudes.

All the above studies indicate that science anxiety is a happening phenomenon in science classrooms and other science related situations and needs further investigation. Science- anxiety is a universal phenomenon which is prevalent among school through university students. In Indian classrooms this phenomenon has been seldom investigated and needs a beginning. Researchers have revealed that science anxiety can have gendered outcome and it defines a necessity to explore this construct in Indian classroom setting which is highly gendered setting.

1.7 Science and Emotional Stability

The emotions are like mirror image of one's mind-set. They reflect the reactions of the individual towards a particular stimulus. Here comes the importance of emotional stability of the learners. Another variable determining the good performance of students in science is their emotional wellbeing**.** The emotions associated with vivid life experiences may facilitate or hinder the teaching-learning process. Hence emotional stability is a desirable quality for fruitful learning outcomes. The root of emotion as a psychological construct is derived from type and trait theories of personality. Particularly Cattell's trait theory and Eysenck's type theory need to be mentioned for their contributions in personality theories. Both these theories recognizes emotional stability as one of the trait or type of personality respectively in their theories. Cattell et al. (1970) identified 16 Personality Factors (16PF) and developed a questionnaire on personality assessment wherein subject responses are scored on variability of responses on personality traits kept on a continuum from low to high score description. One of the factor named as C describes being emotionally stable and facing reality as a high score description in comparison to being affected by feelings and getting easily upset as a low score description. Similarly Eysenck chose certain personality dimensions on which individuals are assumed to vary, which he defined as personality type. His personality system comprises of four dimensions viz. Intelligence as the only cognitive dimension, extraversion-

introversion, neuroticism-stability and psychoticism-stability. The causal factors in Eysenck's theory, are deeply rooted in biology , are highly complex and heavily relies on initial work of Pavlov, 1927 and Hull,1943 (Peck & Whitlow,1975). The neuroticism dimension is similar to the notion of emotional instability (Peck & Whitlow,1975). It means individuals who fall at the extreme end of neuroticism dimension tend to be more susceptible to worries, anxieties and under extreme stressful conditions are prone to develop neurotic disorders whereas the opposite extreme end defines a highly emotional stable state.

The background of these two personality theories clearly defines emotional stability as highly desired mental state which contributes towards the wellbeing of the individual in holistic way. Emotional stability is one of the five personality traits of the Big Five personality theory which identifies five factors of personality as Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience based on Five factor model (FFM) as designated by Goldberg in 1981 (McCrae & John, 1991). Emotional stability is measured through the factor Neuroticism. Emotional stability refers to a person's ability to remain stable and balanced. At the other end of the scale, a person who is high in neuroticism has a tendency to easily experience negative emotions.

According to Chaturvedi & Chander (2010) Emotional instability or immaturity points to an individual's failure to develop the degree of independence or self-reliance that is seen in a normal adult, with consequent use of immature adjustive patterns and inability to maintain equilibrium under stresses, unlike most individuals who do not have these negative traits.

Studies also report that emotional stability is a highly varying trait and is associated with gender as well. According to Aleem (2005) the male undergraduate students are more emotionally stable than the females which may be due to the fact that females are more susceptible as result of feelings of insecurity, lack of ability to adjust. It poses an obvious question in mind, are emotions gendered? This leads to further more curious queries with regard to gender studies.

The term 'emotional well being' is being frequently spelled in recent literature which overlaps with the psychological construct of emotional stability.

The National Institute for Health and Care Excellence (NICE), England has used the term 'mental wellbeing' in its work on children's mental health. Its definition of mental wellbeing is subdivided into three dimensions: emotional wellbeing, psychological wellbeing and social wellbeing.

Children's 'mental wellbeing' encompasses three domains as defined by NICE (Adi et al. 2007),

i)Emotional wellbeing (including happiness and confidence, and the opposite of depression/anxiety); ii) Psychological wellbeing (including resilience, mastery, confidence, autonomy, attentiveness/involvement and the capacity to manage conflict and to problem solve); and iii) Social wellbeing (good relationships with others, and the opposite of conduct disorder, delinquency, interpersonal violence and bullying).

It has been evidenced through research that physical, cultural and emotional health and the school environment in which teaching and learning are expected to occur dramatically impact a student's ability to succeed.

Berger et al. (2010) tried to investigate the effect of emotional wellbeing on academic achievement which was an overlooked perspective pertaining to the fact that traditionally schools are solely focusing on cognitive development and academic training of students for showing educational

outcomes. They adopted a multilevel perspective to test this association among Chilean elementary students, considering features at individual (socio-emotional well-being, self esteem, and social integration) and social levels (classroom social climate and social network characteristics). Results of the study showed significant correlations between socio-emotional wellbeing, self esteem, social integration and a positive perception of the school social climate, and academic achievement. In particular teachers' ratings of their students' self esteem is strongly associated with academic achievement.

According to Barry et al. (2015) within the context of schools, social and emotional learning (SEL) involves the integration of two interrelated strands to promote successful school performance and youth development which are (i) skills development and (ii) supportive environments.

The emotional wellbeing of students needs to be studied in depth as it relate to their emotional stability. The emotional stability of students may have a positive impact on their achievement in science. There seems to be a positive correlation between positive emotions and academic achievement. Similarly it can be linked with students' achievement in science.

Alsop (2005)through his review of literature suggested that emotions such as joy, love, happiness and hope, have a considerable influence over what happens in classroom which act to enhance education, optimize student enjoyment and achievement.

Izard (2002)saidemotions contain useful information that can guide both cognition and action. They occupy a central place in human life but still its importance was recognized very lately in science until the last quarter of the 20^{th} century.

Medina (2008) states that emotions affect how and what children learn. If they remain unchecked it can raise an individual's stress level and stressed brains find it very difficult to learn.

Brígido etal. (2013) states that emotions and feelings play a vital role in the development of learning, since the subjective and emotional world that we each create on top of our external reality gives meaning to relationships, and helps us understand the place we occupy in the wider world.

This means that values like tolerance, patience, dedication and commitment, flexibility and not over expecting from every situation are some of the desirable virtues of an emotionally sound and stable personality. These virtues also facilitate the spirit to scientific enquiry. They foster the scientific temper and zeal to know more. Similarly, an emotionally stable child has the capacity to make effective adjustment with himself, members of his family, and his peers in school, society and culture.

Science teaching-learning process equally demands the emotional wellbeing of learners so that they can achieve the maximum out of the subject.

Alsop (2001)claimed that contemporary school science is being portrayed as rational and non-emotional in recent times consistently overlooking the aspect of affect in studying and doing science.

Alsop & Watts (2003)confirmed through their study that science education is not limited to cognition rather it becomes more meaningful when it targets the affect of the learners.

Reiss (2005) said that emotions are vital factors in deciding the fate of students in science but sadly a very little attention has been given to emotions in sciences in the recent past.

It can be concluded after reviewing the above definitions that emotions means a lot in manifestation of a human being and emotions govern learning and understanding of any kind. This truth holds true for teaching-learning contexts of science as well, in fact to a much larger extent than it was viewed in past through the contriving lens of cognition alone.

1.8 Science and Science Achievement

There had been tremendous efforts worldwide that aims to improve the students' achievement in science both at school and higher education level. In fact a need is felt to inculcate the attribute of scientific way of thinking right from the early childhood times as learning science is all about disciplining the mind to adopt scientific method. Many researches reveal ways to foster virtues like scientific attitude, thinking, motivation, temper, aptitude, creativity amongst the mind of young learners. Also a serious investigation goes into understanding the student related factors influencing their achievement in science like their emotional state, level of anxiety felt for the subject in specific and the kind of science phobia experienced by them.

The achievement in science is largely dependent on the individual involvement of the students and the kind of effect the school is having on them. Therefore the individual differences of the learners do reflect on their scores in sciences. There are two distinct category of variables related with science achievement which are, i) Student related factors and ii) School related factors. Some of the Student related factors comprises of age, SES, emotional wellbeing, scientific creativity and temper, parents' education, parental attitude towards science and School related factors mainly comprise of teachers' viewpoint towards Science, principal's viewpoint, curriculum and instruction, classroom practices, laboratory experiences (hands on experiences).

Students with low SES are seriously disadvantaged in school when school operations emphasize ability groups and curriculum tracks that stratify students on the basis of their SES (Ma & Wilkins, 2002).

In an Iranian meta- analytic study it was reported that in past many studies have been carried out in order to identify the factors related to academic achievement and much of the explored factors are that of cognitive factors, peer relationship, socio-economic condition, the quality of university education, effect of emotional intelligence on academic achievement (Ranjbar, Khademi & Areshtanab, 2017).

According to a American statistical summary report on social background differences in high school mathematics and science course taking and achievement (1995) which examined the relationships between the numbers of courses in mathematics and science that high school students complete and their achievement on standardized tests, it was found that socioeconomic class differences among students are the strongest correlate of persistence in these curricula such that students belonging to high socioeconomic class are having advantage of higher achievement in mathematics and science. The report found that blacks and hispanics complete fewer courses than whites and asians, but these differences largely vanish once socioeconomic status differences between racial-ethnic groups are taken into account. However sex related differences, in contrast, are small and generally insignificant in both subjects.

Ichikawa(1990) enumerated eight distinctive characteristics of the Japanese education system viz. (i) The way that schooling and school education dominate children's and young people's lives; (ii) the privatized development of pre- and post-compulsory education and the large share of private funding for education; (iii) the preference for general education under a single-track system; (iv) automatic promotion between the grades based on age; (v) the low enrollment of non-Japanese

students and adults in schools; (vi) the high educational achievement with low level of deviation; (vii) the unique screening function of entrance examinations; and (viii) the practice of autonomous school management. Through this description it can be concluded that Japan has prioritized high stakes for educational outcome by not compromising on students' achievement outcomes at school.

The influence of the schooling process on the learning of science occurs through classroom practices, laboratory experiences, and curriculum and instruction and responsible, to a large degree, for gender differences in science achievement (Ma & Wilkins, 2002).
In an Indian study, Chand & Himanshu (2013) reported that there are personal, socio-economic and school level factors which can be regarded as determinant of academic achievement in science. The studied personal level factors comprised of hours of self study put in by students and their scores in previous board examination of 10th standard. Among the socio-economic factors, mother's education, working mothers, family income and higher social group emerge as significant predictors of academic performance and among the school related factors, while teacher experience, salary are important factors associated with students' academic achievement in science.

Achievement in science is often taken as an overall reflection on learner's ability for a particular level of learning. How a child performs in sciences suggests how much potential he possesses for the future. Achievement in science ranges from high to low. On one hand where high achievers are highly motivated for further learning the low achievers feels the pressure of science examinations and fear of the results on the other hand. Low achievement in sciences, particularly the hard science Physics and Chemistry is not merely related to intelligence level of children but rather a cumulative outcome of the emotional experiences associated with the subject, socio-economic conditions, parental attitude towards science education, teachers' expectations and of course the student's self-temperament for the subject. There emotional wellbeing is often the underlying cause of their interests in sciences, the SES (Socio Economic Status) is an indicator of the extent to which they are facilitated to progress further as the low SES is often a limiting factor in child's progress. Parental care decides how much they know their child and how parental attitude towards science education can shape up their child's mind to be motivated for science learning. Parental education also plays critical role in molding the child's future especially that of mother. Teachers' view towards science education is very much detrimental to influence student to enjoy, learn and appreciate sciences and finally students' individual scientific temperament is very crucial for his consistent interest for the subject over the coming years. Students' interest in the subject is also displayed through the possession of the trait of scientific creativity which has further linkage with application of scientific knowledge. A greater role is played by emotional profile of the learners as a highly motivated learner has been found to defy all the possible limitations for his excellence in the subject. High achievement in science is one of the strongest parameter to evaluate progress of nation and international standards have been set for its assessment and evaluation. It is a widely accepted fact that nations who invest heavily on high achievement in sciences and mathematics are the ones who are going to be major decision makers in future. Sadly, India's performance has been very disheartening at international platform. If the performance of Indian students in the two international studies, TIMSS and PISA is analyzed, it is found that they have no recognition.

Both PISA and TIMSS have been used by many countries for benchmarking (Yee, Lange & Schmidt, 2000). TIMSS(Trends in International Mathematics and Science Study) established by IEA(International Association for the Evaluation of Educational Achievement) was first conducted in 1995 and performed every 4 years assessing 4^{th} and 8^{th} graders in mathematical and scientific literacy and PISA (The Programme for International Student Assessment) first conducted in 2000 organized by OECD (Organization for Economic Co-operation and Development) conduct 15-years-old school pupils' scholastic performance on science, mathematics and reading after every three years. Recently OECD released the results of 2015 global ranking and Singapore is the proud country to top the charts in all three areas of mathematics, reading and science. Asian countries, namely, China, Korea, Japan, and Singapore are some of the high performing countries in TIMSS. In both these world ranking studies we stand nowhere. Only in PISA 2009, India was a participating nation only for two states of the country namely Tamil Nadu and Himachal Pradesh. For PISA, 2009 India was hardly recognized for her performance, ranking 71 out of 73 participating nations. India has not participated so far in TIMSS. Keeping this backdrop in mind it is felt by the researcher that real serious efforts to uplift the standard of India, especially in terms of science achievement is an essential need of the hour.

1.9 Rationale of the Study

Science curriculum in schools holds a linkage to liberal ideologies, enlightened minds, just society and a progressive nation. Hence the national science curriculum needs to reflect on cultivation of all those virtues in students that make them responsible citizens of the country. As far as performance of Indian students in science subject is concerned their recognition on the international platform (like TIMSS and PISA) is seldom noticed. It was only in year 2009 recently when India went for participation in any international level assessment programs in reading, science and mathematics other than international olympiads. India's poor performance in the Programme for International Student Assessment (PISA) tests sparked a raging controversy about the adequacy of our education system. It proved out to be a litmus test for the country to realize the level of ignorance for subjects of mathematics and science in our educational system.

The existing state of science education in the country compels the researcher to highlight its importance in 21^{st} century which is in heavy need of scientifically trained manpower.

Although for the pursuit and promotion of science and mathematics the MHRD (Ministry of Human Resource Development), India and DST (Department of Science and Technology), India supported India's participation in science and mathematics assessment at international level. The National Board of Higher Mathematics (NBHM) of the Department of Atomic Energy (DAE) initiated activities leading to India's participation in the International Mathematics Olympiad (IMO) from the year 1989. But these efforts are just nothing to improve the level of students' achievement. A far more needs to be done, especially in providing equitability in access to education and wiping out the easy going attitude of the governing authorities towards providing quality education. The official documents narrates the picture of students' achievement in terms of quantified figures of enrolment and retention of children in elementary education and the quality of education being delivered most of the time takes the back seat. It is high time to realize this mistake which has started forecasting its dark shades.

Certain key variables in context of science like scientific temper, scientific attitude, scientific aptitude, scientific creativity, science interest, science motivation all need to be fostered to extend the access of scientific literacy to one and all. The extent to which these factors are taken care of in science teaching and learning process gives the overall reflection of kind of science education which is imparted to the students. The factors that contribute in enhancing scientific literacy comprise of cognitive, affective and socio-cultural dimensions. The cognitive dimension has been always an immediate interest area of maximum studies undertaken so far exploring the factors of intelligence, learning, aptitude and how they relate to students' academic achievement and achievement in science and mathematics especially. The societal influence on student's life experiences can never be overlooked as well. The favourable socio-cultural and socio-economic factors are very strong indicators of positive impact on students' academic achievement and hold a positive relationship with achievement in science and mathematics. Similarly the affective domain have a range of variables which are being investigated or yet to be explored for their association with students' academic achievement. How much inclination students possess for science subject is an outcome of all the aforementioned dimensions. The cognitive abilities of the students, the socio-cultural and socio-economic status of students and the emotionality of students all together influence the trait of scientific inclination amongst the students. The scientific inclination of students emerges out to be an area of interest as it can predict their future performance. This inclination towards the subject heavily rests on student's emotions attached with the subject. These emotions are expressed through the way of handling situations, finding solutions and solving problems. It is suggested that not only cognition but emotions are also translated to actions. Owing to this fact it is further found that positive emotions relate to positive or desirable traits in a personality to improve students' achievement in science and negative emotions results in undesirable traits for the same. Several emotions may contribute to the trait of scientific inclination like temper, motivation, love, feeling of pride, sense of joy. All these positive emotions are equally important along with cognitive abilities of the learners.Emotions such as joy, love, happiness and hope, have a considerable influence over what happens in classroom which act to enhance education, optimise student enjoyment and achievement (Alsop, 2005).The role of emotions has been mostly in the compromised state when it comes to teaching-learning situations in science. In social sciences and languages, the role of affect has been always utilized and it is also very much in the character of these disciplines that affect finds an inbuilt composition in their delivery. But it is very sad that science as a discipline sometime becomes very hostile for students and they treat it as a dry discipline which is not the case. There is a serious need to change this notion and take the advantage of one's affect in making science teaching-learning experience more meaningful for both students and teachers. The review of literature provides a firm rational for the conduct of study focusing on the affective domain of the learner.In India from time to time affective variables have been studied, especially as a psychological variable but very few attempts have been done to find its relationship with the subject of science. A comparative analysis of studies done so far with regard to affective variables like scientific temper and science attitude; science motivation; science anxiety and emotional stability reveals that there are relatively fewer studies on their impact on the science achievement of students. There is a need to understand the role of affect in relation to science, especially in our country were no specific study to understand this relationship has been done so far and needs a beginning.

The present study is based on the research setting of Mizoram. As far as the cultural and ethnic context of the Indian state of Mizoram is concerned it is very unique. In terms of culture it has a native tribal culture which has turned out to be possessing very modern traits under the foreign influence over last century. It is a mono-ethnic group inhabiting the north-eastern part of the country. Culture and heritage wise it is a common observation that 'Mizos' possess traits of enjoying life and feeling happy. Certain soft skills like good communication skills, lively nature, low stress level in day to day living are very much part of students in Mizoram. They exhibit positive emotions at large and participate in all forms creative endeavours. Again looking through the cultural and ethnic lens Mizo students exhibit some unique personal traits like creativity, musical bend of mind, hard work and co-operation which can have a positive impact in their academic achievement and very much facilitate them to progress in every sphere of life. Further, such characteristic features can also have a positive impact in their science achievement. The background to define a rational for the conduct of the present study is derived from students' under achievement in sciences in Mizoram in the last decade in spite of high literacy rate in state, positive environmental outlook for education and favourable cultural milieu in the state. In context of Mizoram the scenario of science education has not been so pleasing. The Mizoram Board of School Education took birth in 1975, when the school level education got detached from Assam board. The results of HSLC examinations conducted by state board since 2000 to 2010 reveals that the overall passing percentage of students had never been above 66.60 % the highest being in year 2010 (Zohmingliani, 2012). If the students' population in Higher Secondary School Leaving Certificate (HSSLC) examination is compared between the years 1997-2000, it is revealed respectively 7.23, 11.25, 13.44 and 9.41% of students enrolled for sciences stream compared to 87.63, 84.93, 81.92 and 87.85% in arts and humanities respectively (MBSE Data). A similar comparison of this enrolment in the last decade between the years 2001-10 revealed that relatively a very less percentage chose science as their stream and a very high percentage chose arts and humanities. According to Zohmingliani (2012) the number of students appearing for examinations in science stream at higher secondary level was found to increase however very steadily from 10.72% in the year 2002 to 23.24% in the year 2010.

In order to reform the system of education in the State of Mizoram, the Government of Mizoram set up the Education Reforms Commission (ERCM) to recommend ways and means to raise standards of education and improve its quality in 2010. The documented summary of the report stated some major aims of education. They are as follows, i)Equipping the Mizo youth to excel in various walks of life at the local, national and international levels; ii)Striving for emotional integration with the rest of the country while safeguarding the Mizo identity; iii)Striving for modernization through development of scientific temper among students along with respect for wholesome traditions of the Mizo society; iv)Inculcating social, cultural and moral values of Mizo communities along with secular values enshrined in the Indian Constitution; v)Ensuring inclusive and balanced development among different socio-economic groups, ethnic groups and geographical regions; vi) Building a strong foundation for the scientific, technological and industrial development in the State.

With these aims the reports also acknowledged about the fear that exists in the minds of Mizo students for mathematics and science education. A line from the summary text states, "unfortunately, the fear associated with mathematics and science requires more innovative approaches to the teaching of these subjects through pattern recognition and focus on concepts involving children through activity based learning using constructivist paradigm."

This fear prevailed for long in the past to the extent that in 2009 it was suggested by the state government to the ERCM members to either make the subjects of mathematics and science optional at secondary level or come up with means of making the subjects easily understandable to the students. The background of this long lasting fear within the government officials, educational stakeholders and students needs an investigation. The very obvious questions that emerge out in this research setting is that, if the personal level traits of students and societal setting does not seem to be unfavourable for learning science and may not be the limiting factors for the same, what may be the probable factors hindering their performance in science subject? What are the probable causes that lead to underperformance of students in science? In spite of reflection of favourable traits for scientific mind what are the hindering forces in students' achievement in science?
The researcher strongly believes that Mizo students are equally capable of exhibiting a good performance in subject of science and mathematics provided favourable environmental factors are ensured. The present research setting compelled the researcher to ponder on one main guiding question which is:"How can we harness the benefits of affective traits in improving student's involvement, attachment and achievement in science?

Now it is evident that affective domain of learner has an important role in scientific achievement, thereby making an impact on societal development. Mizoram being isolated from mainland due to its geographical location and a very scant representation of the population has been observed at national level, at least in the arena of science; it would be very interesting to measure various affective level traits in this population because of its unique setting. Science teaching results in the development of spirit of scientific inquiry and adoption of scientific method in our ways of living. The affective level variables of scientific temper/ scientific attitude, science motivation, science anxiety are the outcomes of one's interaction with the science subject. Definitely these factors find their reflection in students' achievement in science. There is a serious need felt to investigate some of these outcome variables to access the kind of science experiences available for the students. Also the personal level variables of the learners like, emotional stability play a critical role in their achievement in science. How well the emotional state of the learner is also finds its reflection in their achievement in science. Hence, the mentioned four affective variables in relation to science education have been chosen for the present study. The process of development of instruments related to measurement of these four variables has been explained in the methodology of the study.

1.10 Research Questions

To investigate this underlying rationalized philosophy of relationship between affective traits of learners and their achievement in science following research questions have been formulated:

1. What is the level of scientific temper, science motivation, science anxiety and emotional stability, amongst the secondary school students, and what is the nature of distribution of these scores in terms of skewness and kurtosis?
2. Are there gender variations in the scientific temper, science motivation, emotional stability, and science anxiety of secondary school students?
3. What is the level of achievement of secondary school students in science, and what is the nature of distribution of their achievement scores in terms of skewness and kurtosis?
4. Are there gender variations in the academic achievement of secondary school students in science?
5. Do the scientific temper, science motivation, emotional stability, and science anxiety have any significant impact on the academic achievement of the secondary school students in science? If so, what kind of effect they have on the academic achievement in science?
6. What is the level of scientific temper, science motivation, emotional stability, and science anxiety among low and high achievers in science?
7. Do the school level factors like institution's vision and mission, curriculum, teaching practices and teachers' commitment strong indicator of students' achievement in science?
8. Does the construct of scientific temper harmonize with the spirit of nature of science?

1.11 Statement of the Problem

To find out the relationship of affective level variables of science learning with the students' achievement in science the problem stated is as follows:

"Impact of Selected Affective Variables on Achievement in Science of Secondary School Students in Aizawl District of Mizoram"

1.12 Operational Definition of the Terms used

1. **Selected Affective Variables:** Here the term Affective Variables in relation to Science Subject refers to Scientific Temper, Science Motivation, Science Anxiety and Emotional Stability
    - **Scientific Temper**: Here the term Scientific Temper refers to the possession of a mind-set by the students that uses scientific method as a way of problem solving in their day to day life.
    - **Science Motivation**: Here the term Science Motivation refers to a psychological state of students that arouse them to perform better in science subject.
    - **Science Anxiety**: Here the term Science Anxiety refers to the general fear or aversion by students toward science concepts and science-related activities as a whole.

- **Emotional Stability**: Here the term Emotional Stability refers to individuals' steadiness of mood and ability to remain calm when faced with pressure or stress.

2. **Achievement in Science**: Here the term achievement refers to the extent of attainment of science concepts by the students at the secondary level of education. The MBSE (Mizoram Board of School Education) results of class X are taken as the criterion of the students' achievement in science.
3. **Secondary School Students**: Here secondary school students refer to all the students of Mizoram studying in standard X.

1.13 Objectives of the Study

1. To figure out the level of scientific temper, science motivation, science anxiety and emotional stability amongst the secondary school students and to study the nature of distribution of these scores in terms of skewness and kurtosis.
2. To assess the level of achievement of secondary school students in science and overall achievement, and to study the nature of distribution of their achievement scores in terms of skewness and kurtosis.
3. To compare the high and low achievers in science in relation to their scientific temper,science motivation,science anxiety, andemotional stability.
4. To examine the gender variation in scientific temper, science motivation, science anxiety, and emotional stability amongst the secondary school students.
5. To examine the gender variation in science and overall achievement amongst the secondary school student.
6. To find out the gender differences within high and low achievers in science in relation to their Scientific temper,Science motivation,Science anxiety, andEmotional stability.
7. To find out the relationship between science achievement of secondary school students and selected affective variables (scientific temper, science motivation, science anxiety, and emotional stability).
8. To find out the relationship between overall academic achievement of secondary school students and selected affective variables (scientific temper, science motivation, science anxiety, and emotional stability).
9. To measure the net and collective impact of scientific temper, science motivation, science anxiety, and emotional stability on science achievement of secondary school students.
10. To measure the net and collective impact of scientific temper, science motivation, science anxiety, and emotional stability on overall achievement of secondary school students.
11. To assess the situational classroom related variables in context of science teaching learning practices.
12. To understand the complementarities between scientific temper and nature of science (NOS).

1.14 Research Hypotheses

To conduct the present study following research hypotheses are formulated-

1. High achievers in science have higher level of scientific temper whereas low achievers in science have a lower level of scientific temper.
2. High achievers in science have higher level of science motivation whereas low achievers in science have a lower level of science motivation.
3. High achievers in science have right level of science anxiety whereas low achievers in science have a higher level of science anxiety.
4. High achievers in science have higher level emotional stability whereas low achievers in science have a lower level of emotional stability.

5.0 This hypothesis relates to gender differences among secondary school students in affective variables covered in this study, and has been divided into the following sub-hypotheses

5.1 There is a significant difference in scientific temper with respect to gender.
5.2 There is a significant difference in science motivation with respect to gender.
5.3 There is a significant difference in emotional stability with respect to gender.
5.4 There is a significant difference in science anxiety with respect to gender.
5.5 There is a significant difference in science achievement with respect to gender.
5.6 There is a significant difference in overall achievement with respect to gender.

6. There is significant difference in scientific temper of high achievers with respect to gender.

7. There is significant difference in science motivation of high achievers with respect to gender.

8.0 This hypothesis relates to gender differences in high and low science achievers in relation to the selected affective variables, and has been divided into the following sub-hypotheses

8.1 There is significant difference in science anxiety of high achievers with respect to gender.
8.2 There is significant difference in emotional stability of high achievers with respect to gender.
8.3 There is significant difference in scientific temper of low achievers with respect to gender.
8.4 There is significant difference in science motivation of low achievers with respect to gender.
8.5 There is significant difference in science anxiety of low achievers with respect to gender.
8.6 There is significant difference in emotional stability of low achievers with respect to gender.

1.15 Null Hypotheses

To conduct the present study following null hypotheses are formulated:

1. There is no significant difference between high and low achievers in science with respect to scientific temper.

i) There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension ‘curiosity’.

ii) There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'open mindedness'.

iii) There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'objectivity'.

iv) There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'rationality'.

v) There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'aversion to superstition'.

2. There is no significant difference between high and low achievers in science with respect toscience motivation.

i) There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'intrinsic motivation'.

ii) There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'career motivation'.

iii) There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'self-determination'.

iv) There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'self-efficacy'.

v) There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'grade motivation'.

3. There is no significant difference between high and low achievers in science with respect to science anxiety.

i) There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'fear of testing'.

ii) There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'application of science'.

iii) There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'performance in front of others'.

iv) There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'teachers' behaviour, teaching style and teaching environment'.

v) There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'content mastery'.

vi) There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'parents' expectation'.

4. There is no significant difference between low and high achievers in science with respect to emotional stability.

5.0 This hypothesis relates to no significant gender differences among secondary school students

in relation to selected affective variables and has been divided into following sub-hypotheses.

5.1 (a) There is no significant gender difference in secondary school students with respect to their scientific temper.

(b) There is no significant association between gender and level of scientific temper.

5.2 (a)There is no significant gender difference in secondary school students with respectto theirscience motivation.

(b) There is no significant association between gender and level of science motivation.

5.3 (a)There is no significant gender difference in secondary school students with respect to their science anxiety.

(b) There is no significant association between gender and level of science anxiety.

5.4 (a) There is no significant gender difference in secondary school students with respect to their emotional stability.

(b)There is no significant association between gender and level of emotional stability.

6. There is no significant gender difference in the secondary school students with respect to science achievement.

7. There is no significant difference between boys and girls of the secondary school studentswith respect to overall achievement.

8.0 This hypothesis relates to no significant gender differences in high and low science achievers in relation to selected affective variables and has been divided into following sub-hypotheses.

8.1 There is no significant difference in scientific temper of high achievers with respect togender.

8.2 There is no significant difference in science motivation of high achievers with respect to gender.

8.3 There is no significant difference in science anxiety of high achievers with respect togender.

8.4 There is no significant difference in emotional stability of high achievers with respect togender.

8.5There is no significant difference in scientific temper of low achievers with respect togender.

8.6 There is no significant difference in science motivation of low achievers with respect to gender.

8**.7** There is no significant difference in science anxiety of low achievers with respect to gender.

8.8 There is no significant difference in emotional stability of low achievers with respect togender.

1.16 Delimitation of the Study

The present study has following delimitation,

- Only Class X students studying in Aizawl district of Mizoram makes the population of secondary school students in the present study.

CHAPTER-2
REVIEW OF THE RELATED LITERATURE

REVIEW OF THE RELATED LITERATURE

2.0Introduction

Research is a systematic search for truth. Truth needs a thorough investigation and perhaps it finds its way through existing realities based on experiment and evidence. The reservoir of literature available for the investigator is like a flash of light, a path finder for identifying the non-futile truth. Truth cannot have multiple meaning, although it can have multiple realities. Review of the existing literature directs the researcher to the most deep rooted reality as well as at the same time enables the researcher to find the gaps between the existing pieces of knowledge. The whole system of knowledge seeking is woven around popular facts, people's views, perceptions, belief systems, opinions, attitudes and value complexes. The new knowledge must identify itself with the already existing universal truths and this smooth anchorage of new knowledge with old, needs detail reviewing of literature available to a researcher. The phase of review of literature in any form of research is the most enlightening phase as it acquaints the knowledge seeker with various facets of knowledge. It is said, that the whole is always greater than its parts and this holistic approach of knowledge seeking requires the research field to be vast enough to accommodate all possible facts from various fields of knowledge. It helps the researcher to suitably identify the research lacunas and find a rationale for the choice of the topic for his/her research. The field of science education is one of the exciting fields for investigation and review of literature in this field links the researcher to a vast arena of knowledge available to him/her for a beginning. With that igniting thought in mind the researcher want to analyze the progress of researches in the field of science education especially in context of educational research in India and establish a proper justification for the choice of the problem in the present study. Studies done outside the country which are directly or indirectly related to the chosen variables of the study have been also incorporated.

2.1Research in Science Education in India: A Holistic View

2.1.1Growth of Research in Science Education (1947 to 2000): A Quantitative Analysis

Soon after India gained independence efforts were made to strengthen the educational system of the country. Some nodal agencies and educational institutions were assigned to co-ordinate and monitor the quantity and quality of education in the country by Government of India. As far as research in science education is concerned it gained momentum only by late 80s. The 'Surveys of Educational Research' were the first systematic attempt initiated by Centre of Advanced Study in Education, MS University Baroda, Gujarat and later taken over by NCERT, New Delhi to compile all doctoral and project level researches conducted in the country. The investigator made the six published surveys as a basal reference to perform a quantitative analysis on growth of research in science education since independence.

Table 2.1 presents a gestalt summary of number of researches done in India in the field of science education.

Table 2.1
Number of Researches done in India in the Field of Science Education (1947-2000)

Sl. No.	Survey of Educational Research	Time-Period Post Independence	Total no. of Studies in Science Education	Percentage
1	A Survey of Research in Education, 1974	Up to 1972	5	1.63%
2	Second Survey of Research in Education, 1979	1972-1978	8	2.62%
3	Third Survey of Research in Education, 1987	1978-1983	49	16.06%
4	Fourth Survey of Research in Education, 1991	1983-1988	62	20.32%
5	Fifth Survey of Educational Research, 2000	1988-1993	61	20.00%
6	Sixth Survey of Educational Research, 2007	1993-2000	120	39.34%
Total			305	100%

Source: ***Fourth, Fifth and Sixth Survey***

The immediate period after independence was very shaky and wasn't a right kind of ambience for conducting massive research in sciences. The aftermath of colonial rule took long for the country to gain self reliance in the field of science and technology. Under the able leadership of India's first prime minister Pandit Jawaharlal Nehru a new chapter began in the history of the nation. Nehru knew the importance of science and technology in changing the fate of the nation and he tried by all means to lay down firm founding pillars of educational institutions across the country. But educational researches in sciences were not much visible in early years of independence and for long period of time were given no attention. A reference to Table 2.1 suggests that research in the field of science education began with a very slow pace and gradually gained momentum by late 80s. If we see the total number of studies done in first three decades of independence, only 13 studies have been documented by 1978 making a meager percentage of 4.25%. By 1980s an improvement was observed in terms of quantum of researches with a steady accelerating trend of 49, 62, 61 & 120 numbers of studies documented respectively in third, fourth, fifth and sixth survey of research in education. The researcher also assumes that number of researches in science education must have had happened in a similar increasing trend during the last two decades in the country. Owing to the limitation of unavailability of any further survey of educational research after the year 2000 the exact figures are not depicted in the present analysis.

Although these figures are not very satisfactory but looking through the context of post-independence emergent conditions they are acceptable to some extent. It had been not an easy beginning for the nation post independence. With the completion of first 50 years of independence gradually there was a growing consensus for performing more and more researches in science education to improve the quality of education in sciences which had been a neglected area for a long span of time.

2.1.2 Thematic Distribution of Research in Science Education: A Quantitative Analysis

It was only from the fourth survey (1983-88) that a chapter on science education was separately introduced in the survey of educational research unlike the first three surveys where the researches in science were documented within chapters of correlates of achievement, curriculum researches, psychology of education, comparative education, tests and measurement which were some of the main focus areas of researches in early 60sand 70s. The first chapter on 'research in science education' was edited together by B. Ganguli & U.C. Vashistha who was very hopeful for the future of science education in the country. They presented a survey wise thematic distribution of research in science education for the first time. This trend was taken ahead in the coming surveys. Clubbing the data from all 6 surveys following is a tabular representation (Table 2.2) of studies done in Science education under various areas of science education in first 50 years of independence. The thematic areas have been arranged in descending order of their relative share in total number of studies.

Table 2.2
Quantitative Analysis of Research in Different Thematic Areas of Science Education

Sl. No.	Thematic Areas of Science Education	No. of Studies	Surveys	Percentage
1.	Science Teaching & Strategies	73	All Surveys & other sources	21.73%
2.	Cognitive studies of Science	40	5th and 6th Survey	11.90%
3.	Achievement of students in Science and its Correlates	39	All Surveys & other sources	11.60%
4.	Affect & Skills in Science (Scientific Temper, Attitude & Aptitude, Questioning Skills, Interest, Students' Attitude towards Science)	37	2nd, 3rd, 4th, 5th, 6th Survey &other sources	11.01%
5.	Science curriculum and Textbook evaluation	36	All Surveys and other sources	10.71%
6.	Use of Educational Technology in Science Teaching & Development of Teaching Material	25	2nd, 3rd, 4th, 5th& 6th Survey	7.44%
7.	Environmental studies/ factors	24	3rd, 4th, 5th& 6th Survey	7.14%
8.	Construction of Tests in Science	16	1st, 2nd, 3rd& 4th Survey	4.76%
9.	Learning Science and Models of Teaching	15	5th Survey	4.46%
10.	Scientific Creativity	11	3rd , 5th& 6th Survey & other sources	3.27%
11.	Critical Review on Position of Science teaching and education at National and state levels	6	3rd ,4th & 5th Survey	1.78%
12.	Gender issues in Science Teaching	6	6th Survey	1.78%
13.	Status of Science Laboratories	4	3rd , 4th Survey	1.19%
14.	Science education abroad	3	4th and 5th Survey	0.89%
15.	Philosophy of Science/Scientific method	1	4th Survey	0.29%
16.	Historical and Comparative Studies in Science Education	-	-	-
17.	Policy studies	-	-	-
Total Studies till 2000		336		

Source: ***All Surveys of Educational Research***

An analysis of the summative figures in Table 2.2 reveals that some thematic areas in science education have been consistently documented in all the surveys of educational research which are science teaching & strategies, correlates of achievement and science curriculum & textbook evaluation making an overall contribution of 21.73%, 11.60% and 10.71% respectively with research in the area of science teaching & strategies being the most opted theme.

Curricular studies in sciences were perhaps the first theme chosen in the area of research in science education with 36 studies documented in the surveys. The first study done in India after independence was by Kelkar (1950) who offered a tentative course of study in general science for the secondary schools. Veerapa (1958) examined the trends in science education from primary through the degree course level and found that due to lack of proper laboratories, and effective science teachers science education in India was not on a proper footing. Some measures were taken to study the existing science education programmes, suggest a better curriculum for science subject and improve the textbooks at primary and secondary levels in various states, which has been the approach taken by Joshi (1972), Singh (1977), Uppal (1977), Joshi (1979) in Maharashtra; Radhamonyamma (1980); Cherian (1988) & Radhamony (1988)in Kearla; Sharma (1982) in Bihar; Desai (1986) in Karnataka; Sundararajan (1988) in Tamil Nadu; Mohanty (1988) in Orissa and Begum, (1990) in Andhra Pradesh. A similar approach was taken by Singh (1985) for biological science at undergraduate level in the state of Uttar Pradesh. Brahadeeswaran (1986) & Arora (1986) tried to study the effectiveness of chemistry curriculum of the polytechnics and science curriculum of teacher's training programs respectively. The curriculum researches were done mostly at the state level with few comparative studies of central and state level curriculum. The outcome was enlightening at the state levels as it helped in improvement of curricular researches. Interstate curricular comparative studies were performed by Krishnan (1981) and Goyal (1982). Newer experiments with activity and environmental based curricula to improve students' learning at primary levels were tried respectively by Patole (1967), Rajput, Saxena & Jadhao (1980). Ramesh (1984) studied the efficiency of objective based science curriculum in the acquisition of process skills and found that that high ability group students performed better in chemistry when they were taught by objective based curriculum than the high ability group taught through the conventional curriculum. Uchat (1982) tried to find the science subject preferences within the students and found that physics was considered as the most difficult subject and biology was considered as the least difficult subject.Raveendranathan (1983) &Mukhopadhyay (1983) tried to see the impact of medium of curricular instruction and its comprehensibility on science achievement.

As far as studies in the field of science teaching and strategies are concerned the most number of studies fall into this theme with a total of 73 studies. It implies that one of the main areas of educational researches in science has been a constant focus on finding ways of improving the teaching learning processes of classroom. Different teaching approaches and strategies such as problem-solving(Kamalakanthan,1968),demonstration-activity(Sharma, 1978 & Jha, 1979), modular approach (Hopper, 1982)**,** system approach (Anjaria,1984), open ended approach (Gangoli & Gurumurthy, 1985), concept based approach (Khalwania, 1986), inquiry based

approach(Menon,1986), guided-discovery(Gurumurthy,1990 & Shishta, 1990), individualized instruction (Goel & Agbebi, 1990), peer-tutoring(Gyanani & Pahuja,1996) and cooperative learning **(**Banerjee & Vidyavati, 1997), were tried out experimentally and all of them were found to be superior than the traditional approaches of teaching sciences (physics, chemistry, biology). Muddu (1978), Adinarayan (1979, 1984), Singhal (1983) tried to study the prevalent methods of teaching sciences and found them to be outdated. Joshi (1987) and Agnihotri (1987) designed instructional strategy to teach science at secondary level.Jadho & Parida (1996) and Saxena (1996) performed content analysis of physics content at primary level. Pillai (1987) did experimental study on Gagne's conditions of learning for instruction and found it as efficient strategies to teach physics. Aranha (1988) tried to show the usefulness of mastery learning for slow learners. Amalraj (1994) tried to relate physics learning with inculcation of intellectual, social and aesthetic values.

Parallel to the theme of teaching strategies a new theme emerged by 1980s which was mentioned for first time in the fifth survey as leaning science and models of teaching. In India many models of teaching have been tried since late 80s especially after coming up of Joyce & Weil's work on models of teaching. A total of 15 studies have been reported in this category. Some popular models used for their effectiveness were concept attainment model by Sushma (1987) for biological science, Saxena (1988) for chemistry, Awasthi (1989) and Mohan(1991) for science in general; Jerry Luces memory model for teaching botany by Kayathri (1989); information processing model for acquiring chemical concepts by Aziz(1990). Studies on learning strategies were equally opted during this time which was dominated by Piagentian cognitive psychology. Grewal(1988) through her research emphasized on usefulness of process approach in science teaching. Vaidya (1991) in his longitudinal study found that there is an existence of a 'hump effect' where thought progresses, regresses and again progresses till concepts settle down finally in a child's head. In yet another study Vaidya (1994) established two schemes of thought namely 'combinatorial grouping' and 'exclusion of variables' which helped to enhance achievement in science among the adolescents. Some more concept oriented studies were done by Srivastava (1988), Rao (1988), Mohapatra (1989) and Malik (1990). Prakash(1990) and Raghavan (1991) respectively studied the effect of concrete materials and concept mapping to enhance learning in physical sciences. Singh (1989) found that the teachers' behavior while teaching science can be improved by use of creative verbal and non-verbal interaction between the teacher and taught.

The early years of researches in science education were more devoted to test construction. A total of 16 studies were documented in the surveys. Scientific aptitude tests (Guha,1957;Dave,1964;Lele & Parikh1965;Deshpande,1967;Chatterjee&Mukherjee,1967;Deb,1968;Venkataramana,1970; Ganguly, Ghosh, Chatterji & Mukherji, 1972;Giri,1976), achievement test(Ansari,1984),diagnostic test(Gadkari,1982;Verma,1986), battery of selection tests (Pratap,1972;Oommentharakan, 1973;Joshi,1978) vocational interest inventories (Gopalan,1972) were some of the constructed test in this area.

Another frequent area of research was that of application of educational technology and developing newer teaching materials. A total of 25 researches were reported in this area which identified potent

means of enhancing science teaching learning experiences. Some of the studies on use of educational technology were that of Sonar (1975) & Barve (1986) in making use of film strips, Muddu (1978) in using motion pictures and Sivadasan (1981)in designing an audio-tutorial system for teaching science. Some other studies on use of computers were done by Bhattacharya (1989), Shani (1991) and Malik (1992). Studies on teaching material were conducted by Vardhini (1983), Lambhate (1987),Patel (1995), Purundare (1997) and Chand (1998).

Environmental studies were also one of the theme areas opted by researchers with a total of 24 studies documented in the surveys. Exemmal (1980) for the first time used environmental approach for teaching botany. Environmental approach of teaching was one of the most frequently applied approaches in teaching biology adopted by Joshi, B.P. (1981), Joshi (1981), Deopuria (1984) and Vedamani (1988). Studies on incorporation of science centers and science clubs in science teaching were done by Javelkar (1988) and Sivadasan (1988) respectively. While environment based resource materials were developed by Mitra (1989), Ghosh (1990) and Bhattacharya (1990), content analysis of biology textbook with regard to environmental content were done by Durani & Sharma (1981), Durani (1988) and Lehari (1988).

The trend of researches done also varied from time to time. Cognitive studies came into picture in the last decade (1990-2000) following the Piagetian theory of cognition. There are a total of 40 studies documented under this theme. One of the preliminary studies in this area was by Vaidya (1974) who tried to understand problem solving aspect of thinking in science students of adolescent age group and found that their average performance problem solving increased with grade. In yet another study by Bhargava (1983) it was found that the mental process of observing, measuring and drawing inferences showed high correlation with students' achievement in physics and boys were found to be superior to girls on these three processes. Chhikara (1985) found a definite positive relationship between conceptual achievement in life sciences and reasoning ability and it was possible to predict the conceptual achievement on the basis of reasoning ability of students. A similar study by Singh (1988) found a significant positive relationship between the reasoning abilities and achievement of concepts in physical chemistry. Cognitive preference study in physics was done by Saxena (1985) while Jain (1982) studied problem solving behavior of adolescents. Rajrani (1986) showed that the content in the secondary chemistry course are both symbolic and conceptual in nature and Raju (1982) tried to study the interaction of cognitive and affective outcomes of studying secondary school biology. Studies based on Piagetian models were also tried by Srivastava(1988) and Rajagoplan (1995). Studies on misconceptions in science learning was performed by Ansari (1998) and found that achievement of students in biology was inversely proportional to the number of misconceptions/ alternative conceptions held by students at high school level. Other studies on students' concepts and misconcepts were that of Panse, Ramadas &Kumar(1994) and Ramadas & Nair (1996), Mahajan & Chunawala(1999),Chunawala, Natarajan & Ramadas (1999).

Studies on creativity in science were tried in order to know its relationship with intelligence and also due to a guiding thesis that scientist ought to be equally creative and intelligent. A total of 11 studies were found under this theme mainly listed in fourth, fifth and sixth surveys. Some of the studies were

conducted by Srivastava (1977),Usmani(1981)who found science students to be significantly higher on creativity scores in comparison to non-science students; Bhadauria(1980) found thatgifted students possessed greater creative potential in terms of overall mean scores on verbal and literary problems than the other science students; Srivastava(1992) in her study found that there is a relationship between scientific aptitude and creativity; Pachaury (1997) tried to compare the perceptions of scientists and psychologists towards creativity and found that no difference was found in two groups.Both agreed on the point that most desirable traits to be nurtured were to be curious, courageous in conviction, doing independent judgment and being preoccupied with tasks whereas the least desirable traits were shyness and pride.

A handful of critical review on position of science teaching was also tried. The surveys documented four studies at national and two studies at state levels. Wanchoo & Sharma (1974)surveyed the quantity and quality of researches conducted in science and mathematics education in the country to find the research gaps. Later, Barman (1983) tried to study the origin and development of modern science in pre-independent India. Another commendable survey was done by Sharma (1984) who studied the development in school science in India in-between 1947-77. It was found that school science underwent changes during the period of 1952-57 which was advocated by some parallel views. Later general science was universalized which continued till 1957-62. In 1973 the ministry prepared a model curriculum which recommended that school science be taught as environmental studies at the primary stage, as an integrated course at the middle stage and as integrated groups of subjects at the high school stage. A similar study was done by Vaidya (1989) showing the relevance of impact science teaching. At the level of state Bhattacharya (1979) studied the development of science education in states of Assam & Meghalaya and Sharma (1982) did a similar study in the state of Bihar.Exceptionally a study byGupta & Singh (1994) discovered that the status of science teaching in Indian schools for the visually impaired children was in very poor state due to lack of adequate infrastructure, facilities and specially trained teachers.

Few status reviewing of science laboratories, science clubs, fairs and exhibitions were done but they were mainly restricted to states and allied zones. It was after the establishment of Regional Colleges of Education in main zones of the country and State Council of Education and Researches, there was an amplification of such status reviews in various parts of the country. Rajput, Gupta and Vaidya (1978) surveyed science laboratories in the western zone from the states of Madhya Pradesh, Gujarat, Maharashtra and Goa.It was commented by Vaidya (1997) in the Fifth survey of Educational Research that Laboratory culture established in our country by then only tried to promote testing of known facts and theories. It did not try the skeptical attitude within the doers of science who should be independently skilled to testing and verifying new facts and knowledge. The author suggested that there is a need of major reform in the way of cultivating laboratory skills as an important requirement of doing and understanding science.Rao & Gupta (1990)in their survey on status of science laboratories in the states of Maharashtra and Rajasthan found that there was little evidence on the utilization of lab facilities. Pandit (1989)identified eight chemistry laboratory skills in hierarchical order which are to be mastered by the students. Malhotra (1988) found that there was a significant

difference among the public (private), government and central schools in Delhi with regard to use of lab facilities.Natrajan(1983) evaluated the district level science fair and exhibitions in the state of Andhra Pradesh and found that they encouraged students' interest in science.

Gender issues in science education emerged as a new theme lately. Some of the studies in this area were by Sharma (1975) and Pillai & Usha (1994). Only one study on philosophy of science was reported in 4th survey conducted by Vashishtaha (1986) on the topic 'mechanistic and organismic viewpoints in biology and their traces in education'. Sadly there is no study on policy reviews and historical and comparative perspective of science education. Some attempts were done to understand the science education scenario in the countries of Bangladesh, Nepal and Japan by Aziz (1984), Bajracharya (1986) and Makkar (1991) respectively.

The correlates of achievement in science have been vigorously studied in various parts of the country with a total of 39 studies. Most of the researches were confined to familial, socio-cultural and psychological factors and very few studies were focused on the affective domain of learners. The most frequent variable of studies was socio economic status (SES), parental education and profession. Within psychological factors researchers delimited themselves mostly towards the cognitive factors of intelligence and aptitude with few exceptional studies on adjustment, attitude, and interest. As far as research focused on affect and skills in science are concerned a total of 37 studies have been reported, most of them again being the attitudinal studies. The research in these two broader areas is the highlight of the present review since they directly or indirectly relate to the present study and are discussed in the next section of the chapter.

To summarize the gist of the total studies reported in educational surveys we can say that a lot has been done in the first 50 years of independence in the country but the quantum of research is very handful, pertaining to the fact that the country has a huge and diverse landscape. There have been some researches in the field throughout this time period and at the same time few areas remained untouched consistently due to lack of any interest by the researchers. Narendra Vaidya in his trend report of science education for the fifth survey of educational research (1988-92) stated, "*There is no hope for improvement of school science in our country until and unless both the blind and leper, as the Sufi story goes, take each other's help for getting out of the curricular jungle. These blind men and lepers, metamorphically speaking are our content-oriented and education-oriented science education experts and teachers."* This survey was published way back in the year 1997. It was not an encouraging cumulative indicative of the quantum of research done in the field documented in the past four national surveys of educational research. Sugra Chunnawala in her trend report of science education for sixth survey reiterated the research gaps in science education in India, as mentioned by Narendra Vaidya. Both highlighted that there were absolutely no researches in the areas of philosophy of science, scientific method, nature of science and policy studies. Vaidya, suggested some areas of research frontiers to be undertaken by the future researchers to improve the quality of science education which were mainly philosophical researches, history of science, historical episodes, position of science education, school influence and climate on pupil achievement, inculcation of problem solving abilities of student through strategies and curriculum,, the psycho-statistic paradigm

created by teachers, longitudinal studies, handling conflicting findings and research in curriculum for incorporating scientific skills and interest within the students.

In the following section an attempt has been made by the researcher to present some of the important studies done both in India and abroad under the chosen constructs of the present study. The present research review is focusing on those studies which have been done in relation to the chosen affective variables influencing learner's achievement in science. The collected studies have been categorized according to the variables of the study. The present study 'Impact of selected affective variables on achievement in science of secondary school students in Aizawl district of Mizoram' concentrates on science learners' affective perceptive and its impact on their achievement. Here 'achievement in science' is the main dependent variable of study and 'scientific temper', 'science motivation', 'science anxiety' and 'emotional stability' are the independent affective variables of study. Hence forth the reviewed studies are categorized variable wise. Since the study is done in Mizoram, studies on science education from the state have been also included in the review of literature. The studies have been arranged chronologically under each subsection.

2.2Variable Wise Categorization of the Reviewed Studies

2.2.1 Studies on Achievement of Students in Science and its Correlates

There has been an innumerable research investigating the various correlates of achievement in science in our country and abroad from time to time in order to understand the student and teacher perspective of science learning and teaching process, evaluative practices, students' phobia towards the subject and the identification of various factors that contribute in improving achievement in science. Following are some of reviewed studies:

Kulshrestha, S.K. (1956) *A study of intelligence and scholastic attainments of X and XI class students in Uttar Pradesh*

The study aimed to find the significance of differences of intelligence between the students in literature and science groups of study. It was found that science group proved to be superior to literature group in nonverbal test of intelligence, form relations test and group test of general mental ability. Also the intellectual maturity of students in the intermediate science was far superior to the intermediate literature group.

Mishra, H.K. (1962) *Personality factors in high and low achievers in engineering education*

The study was a comparative study of non-academic background and personality structure of high and low achievers in engineering education. The study revealed that the personality patterns of the two groups differed in traits like anxiety, adjustment and neuroticism. There were however no differences in their intelligence, attitude towards teachers, social adjustment and total emotionality. Groups did not seem to differ on other dimensions either.

Rastogi, K.G. (1964)*A study of the relation between intelligence, interest and achievement of high school students*

This investigation aimed at studying the relationship between intelligence, interest and achievement in english and science of high school students. Results revealed that the relationship between interest and achievement in english (r =0.50) and that between interest and achievement in science (r = 0.37) was found to be low. Hence, interest could not be said to be the major predictor of achievement in

science. Intelligence and achievement in science were found to be significantly positive and both interest and intelligence were found to be related more with achievement than between each other. A combination of intelligence and interest was a better predictor of achievement in english and science than either interest or intelligence alone.

Baqer, M. (1965)*Differential factors in predicting success in science, arts and commerce courses at the higher secondary stage*

The study aimed at finding out whether there existed a differential pattern of factors required for successful performance in the science, arts and commerce courses at higher secondary stage. It was done on all three courses of class IX for a period of three years. It was observed that while inductive reasoning assumed the greatest importance for science course, verbal meaning turned out to be the best single predictor for the arts and commerce courses, the magnitude being highest for arts course. The second best predictor for science was verbal meaning, for commerce numerical facility and for arts verbal facility.

Sinha, N.C.P. (1967)*A study of intelligence and some personality factors in relation to academic achievement of school students*

In this study a comparison between science and arts students were performed in relation to their academic achievement where it was found that the two groups were significantly discriminated (beyond 0.01) on all the variables, namely, intelligence, achievement motivation, manifest anxiety, extraversion-introversion and neuroticism or emotionality. Science students scored significantly higher on the intelligence test than the students of arts. Intelligence and academic achievement were significantly related to achievement motivation and manifest anxiety at 0.01 level, and with extraversion-introversion and neuroticism at .05 level of significance.

Jha, V. (1970)*An investigation into some factors related to achievement in science by students in secondary schools*

The study examined the nature of relationship between intelligence, science aptitude, adjustment, anxiety, extraversion, study habits, and socio-economic status on one hand and achievement in science on the other hand. The main finding of the study indicated that there was a significant positive relationship between achievement in science and general intelligence; scientific aptitude and adjustment but there was a significant negative relationship between achievement in science and anxiety in the case of boys and combined samples but not so in the case of girls.

Dhaliwal, A.S.(1971)*A study of some factors contributing to academic success and failure among high school students-personality correlates of academic over , under achievement*

The study revealed that superior study habits, reservedness, high verbal ability, home, emotional and school adjustment, poor social adjustment and security feelings correspond with overachievement, i.e. academic success, whereas inferior study habits, outgoing tendencies, low verbal ability, emotional instability, assertiveness, happy-go-like temperament, poor adjustment in home, emotional and school areas, good social adjustment and insecurity feelings were associated with academic underachievement, i.e. academic failure. Anxiety and need for achievement bore a curvilinear relationship with over and underachievement, implying thereby that both over achievement and underachievement go with higher need for achievement and greater anxiety in comparison to normal achievement.

Pathak, A.B. (1972)*Factors differentiation high and low achievers in science*

The purpose of this investigation was to study factors which would differentiate high achievers from low achievers in science. The important findings were, the high achievers had a significantly higher

mean IQ (131.2) than the low achievers (93.7). 84% of the low achievers frequently expressed fear of failure in examination and lack interest in studies, whereas the high achievers were more optimistic about academic future and they aspired to achieve high standards. The educational background as well as the financial condition of parents was better in the case of high achievers and study habits and skills of high achievers were better than those of low achievers. However, the two groups did not differ significantly with regard to their interest patterns.

Banerjee, T. (1972)*Rorschach whole responses, intelligence and achievement in science*

In this study it was revealed that the Rorschsch whole responses (W) had no relationship with both intelligence and science achievement, while the W+ responses were significantly and positively related to the students' behavior whereas the W- responses were negatively and significantly related to them. Hence qualitatively the features of W+ responses could offer valid estimates of intellectual level and science achievement.

Saxena, P.C. (1972)*A study of interests, need patterns and adjustment problems of over and under achievers*

This investigation sought to discover the differences between the over and under achievers with respect to their interests, need patterns, adjustment problems, study habits, and personal and background factors. It was found that the achievement in an area was found to require interests in associated activities; having interests at random did not discriminate between over and under achievers or from one stream of study to another. Better health status, a positive self-concept and parents' education was found associated with overachievement in mathematics and biology streams.

Agarwal, K.K. (1973)*Prediction of the scholastic success in science subjects with the help of a battery of psychological tests among high school students of Uttar Pradesh*

This research was concerned with the preparation of a battery of psychological tests which could predict success in science subjects of the scientific group of the students in high schools. It also aimed at finding out the factors which contributed to the success in science and at helping the teachers to make proper selection for science course. Findings revealed that the first factor i.e. the general factor had a positive loadings on all the tests conducted (the verbal group test of intelligence, the Minnesota paper form board test, the reasoning test; the numerical ability test; the science information test and the science vocabulary test) and the second factor had high loadings on the criterion (marks obtained in science) named as interest factor. The third factor had loadings on the test of reasoning and Minnesota Paper form board test; it was named as reasoning factor. The two sexes differed significantly on all the tests except the verbal group test of intelligence.

Beedawat, S.S. (1976)*A study of academic under achievement among students*

For this study the data were collected with the help of the Cattell's 14PF (HSPQ), Saxena's personality adjustment inventory, the Frymier's junior index of motivation and Rao's study habit inventory. The major findings of the study were: i) the incidence of underachievement was higher in science groups; ii)the proportion of underachievers among girls was larger than that among boys; iii) 75%of the students among underachievers possesses average emotional stability and vi) about 40% of students were found to be possessing qualities like impulsively lively and gay enthusiastic.

Mathew, T. (1976)*Some personality factors related to underachievement in science*

This study was done on secondary school students which revealed that a higher number of overachievers were in high intelligence, low age group, amongst boys and among the parents with higher education, high income urban group than their respective counterpart. Four factors- total

adjustment, anxiety orientation, group adjustment and self-esteem- accounted for total variance of the overachieving group.

Srivastava, G.P. (1976)*A study of personality factors as predictors of academic achievement of high school students*

In this study 250 science and 94 arts students were chosen and their academic achievement records were procured. HSPQ Form A by Cattell and Bell was used to assess their personalities. The important results of the study were as follows: i) Sizothymia and submissiveness were the factors which discriminated first division holders from second division holders in the arts group; ii) affectothymic, intelligent, emotionally stable, adventurous and self-sufficient students were high achievers (first division) in the science group; iii) high achieving arts students were distinctly sizothymic, whereas high achieving science students were affectothymic.

Chatterjeee, S., Mukherjee, M. & Mitra, S.K. (1978) *Higher secondary science achievement as related to scientific interest and aptitude*

It was found in this study that there was systematic positive relationship between the higher secondary students' science interest and probabilities of success in science at different aptitude levels except higher aptitude levels. At lower aptitude levels interest played an important role in enhancing the probability of success in science. Also the relationship was found positive between aptitude in science and probabilities of success in science. The multiple correlation of interest score and aptitude scores with marks in the higher secondary examination as the criterion was 0.59.

Senapati, B.B. (1980) *A study of interest and ability of the secondary school students in science* In the study on the higher secondary it was revealed that both intelligence and interest taken together were a better predictor of achievement in science than interest or intelligence alone.

Yadav, M. (1984)*Classroom learning behaviour of pupils of different socio economic status and their achievement in science*

In this observational study it was found that classroom learning behaviour like 'listening attentively'; 'volunteer response and ideas'; 'reading book attentively'; 'involvement in writing'; 'reaching teacher for removing difficulty, complicating seatwork, clarifying doubts'; 'giving help to peers' had positive correlation with achievement in science. On the other hand, classroom learning behaviour like 'looking fatigued'; looking distracted and involvement in disruptive behaviour'; 'copying from blackboard'; 'evading seat work' had negative correlations with achievement in science. SES also influences the classroom learning behaviour.

Ghosh, G.P. (1985)*A study of the achievement of the students in chemistry and finding relationship with some of its determinants*

An achievement test in chemistry (ATC) was constructed for the study. It was found that there was a positive correlation between the scores in ATC scores and academic motivation test, ATC and group intelligence test, ATC and income of the parents. It was found that urban students did better in ATC than the rural and boys were not found superior over girls.

Mehna, V. H. (1986)*An investigation into some factors affecting academic achievement in science of standard IX students of Greater Bombay*

It was found that verbal intelligence, motivation for learning general science, scientific knowledge and aptitude, numerical ability, liking for teachers of science and interest in medicine were significant predictors of students' achievement in secondary general science. Abstract reasoning was found as a significant predictor for physics achievement only whereas numerical ability was found to be a significant predictor for achievement in physics and chemistry but not biology.

Sharma, A.(1989)*Personal and social factors affecting the success and retention of girls in science*
In this study it was shown that there is a role of personal and social factors on retention of girls in science and their achievement in science.

Phalachandra, B.(1989)*An analytical study of some correlates in the acquisition of science concepts in school children*
It wasfound that a positive relationship between concept-based achievement in chemistry and environment which was traditionally favouring boys over girls.

Alexander, B. (1990)*A study of the relationship of critical thinking, science aptitude and socio-economic status to the science achievement of second year of P.U.C*
In this study it was found that critical thinking, science aptitude and socio-economic status contributed significantly to achievement in science with some sex differences.

Rao, D.B. (1990) *A comparative study of scientific attitude, scientific aptitude and achievement in biology at secondary school level*
It was found that there is a significant relationship between scientific attitude, scientific aptitude and achievement in biology.

Kar, D.K.(1990) *A study of relationship between attitude towards and achievement in general science of class IX students of Cuttack city*
In this study it wasfound that there exists a significant relationship between attitude and achievement in general science.

Salim Kumar, C. (1994) *The interaction approaches to studying and achievement motivation in biology of secondary school pupils*
The study aimed to study the effect of achievement motivation of students on their achievement in biology at secondary level and found that the variance in the achievement in biology was not dependent on the achievement motivation of the students.

Young,D.J. & Fraser, B.J. (1994) *Gender differences in science achievement: Do school effects make a difference?*
This study tried to find reasons of underrepresentation of girls in Australian schools. It was found that school level differences were contributing more significantly towards explaining variation in students' performance than other correlates. Although statistically significant sex differences in physics achievement for 10, 12 & 14 year old students were obtained but school effects were explaining 9-19% of variances in comparison to gender which explained only 3 % of variance.

Padhi, J.S. (1996) *Effect of competency-based, activity-centered approach to teaching on attainment of mastery level learning in environmental studies*
It was found through the study that the adopted approach of competency-based and activity centred teaching was found to be more effective over the traditional approach in teaching students of grade I.

Lalitha, P.R. & Rao, N.R.N. (1996) *A study of the vocabulary required by class III students to achieve mastery in EVS as per the Minimum Levels of Learning (MLL's)*
In this interesting study it was found that the students possessing good sense of vocabulary did well in EVS.

Santha Kumari, K.M. (1998)in her study on the*influence of classroom climate andapproaches to studying on achievement in physics of secondary school pupils* found that positive classroom climate has significant positive effect on achievement of students.

Usha, P. (1992) in *a study of certain socio-familial correlates of secondary school science achievement* reportedthat educational and occupational levels of both father and mother were

significantly associated with achievement of secondary school students in physical science. Also parents who possess less sex bias towards their wards contributed in getting higher achievement by their wards.

Patel, R.C. (1997) in his studywhile examining the relationship between scientific attitude of secondary school students and their achievement in science and general achievement in Baroda discovered a correlation of 0.5409 and 0.5426 respectively, both of which were found significant at 0.01 level.

Anju, R.D.(2000) in *a comparative study of the effectiveness of mastery learning and inquiry training model on pupils self-concept, creative abilities and achievement in science* found that the pupils who were taught science through mastery learning and inquiry training model scored significantly higher mean score on science achievement than the pupils taught science through conventional method.

Zammit, S., Routitsky, A. &Greenwood, L.(2002) in a studyon trend analysis of *mathematics and science achievementof junior secondary studentsin Australia* in TIMSS.Theyreported that Australian students achieved well above international average in mathematics and stood second next to Chinese Taipeis students in science achievement out of total 38 participating countries. Australian students' achievement in science was at par with 15 other countries including Singapore, Japan, the Republic of Korea, England, Canada and Hong Kong.

Ricketts, J.C.,Duncan, D.W. & Peake, J.B.(2006) in a descriptive and correlational study *science achievement of high school students in complete programs of agriscience education*tried to compare the students' science achievement scores in Georgia High School Graduation Test (GHSGT) with science achievement scores of college preparation and it was found the former scores (Mean=511.24) were approximately three points lower than college prep students (M = 514.85). The correlational analysis revealed that students in secondary education who participated in this study enrolled in an average of four agriscience classes and had a moderate to high level of engagement in the overall agriscience program which included FFA (agriculture leadership program) and SAEs (supervised agricultural experiences).

Sun, L., Bradley, K.D. & Akers, K.(2012)utilized PISA data in *a multilevel modelling approach to investigating factors impacting science achievement for secondary school students: PISA Hong Kong sample*and found that at the level of student perspective, male students; students from higher SES families; students with higher degree of motivation and self efficacy; and students whose parents value science were likely to show better achievement science. From the school perspective it was found that school enrolment size, school SES composition, and instruction time per week are the factors explaining school science achievement.

Lyndem, T.(2014) *A study of attitude towards science in relation to academic achievement of secondary school students of east Khasi hills district*

In this study in the Meghalaya state, it was found that attitude towards science was found to follow a normal distribution and the average achievers were high in number (65.93%) in comparison to high and low achievers at secondary level of education. There was no significant difference observed in academic achievement of male and female students. The correlation between attitudes towards science and academic achievement was very low suggesting that high attitude towards science may not be the indicator of high academic achievement and vice versa.

2.2.2 Studies on Scientific Temper and related constructs (scientific attitude, attitude towards science, science interest)

There are more researches on scientific attitude and attitude towards science than studies on scientific temper. In western literature the term 'scientific temper' is not as popular but an analogous term 'scientific attitude' equally exists. Some studies treat scientific attitude and temper to be overlapping terminologies where former existed in the area of research for a longer period than the later. However, there are some conceptual differences between the two terminologies. As already mentioned scientific temper came into existence after Nehru mentioned it for first time in his book 'Discovery of India' in 1946. Nehruvian temper calls for humanitarian appeal very well explained in the words of Narlikar (1993), "Scientific temper is that self-correcting tendency of rational beings that helps him/her to harmonize between needs and desires."Gardner(1975) distinguished between 'scientific attitudes' and 'attitudes towards science' by saying that former is a complex combination of cognitive parameters within an individual that keep him/her compelling to weigh the evidences before accepting the facts, ask questions, have an urge to know and understand and always guides one decision whereas the later is very much affective in origin that decides one's feeling, belief and value complex towards science, scientists and science related affairs. Scientific attitude is a cognitive parameter measured through one's feeling and hence most frequently kept under affective domain. Following are some studies collected under these overlapping affective constructs:

Sood, J.K. (1974)*A study of attitudes towards Science and Scientists among various groups of students and teachers in India*

In this study an attitude scale to measure the attitude towards science and scientist comparing male and female students and teachers was used to determine their understanding of nature of science. The findings revealed that the sample reflected positive attitude towards science and scientists which was significantly related to understanding of science although the attitudes of students and teachers differed significantly. The difference in understanding the nature of science between science teachers and students was not significant.

Srivastava, N.N. (1980) On the basis of *a study of the scientific attitude and its measurement* an attempt was made to measure the scientific attitude of science and non-science teachers and students. The finding revealed that greater the exposure to science courses and attainment of scientific knowledge, more positive is the scientific attitude. Whereas the boys and girls differed in the levels of their scientific attitudes, the teachers did not differ with respect to their gender.

Shinde, Y. K. (1982) did a study named '*a study of non-formal science activities in secondary schools of Maharashtra state with special reference to their impact on scientific attitude and achievement in science'* where it was found that the scientific attitude and academic achievement of the secondary students was not related to their involvement in non-formal science activities. The boys and girls did not differed significantly in their scientific attitudes and there was better relationship between scientific attitude and academic achievement in case of girls. Students with

high, average and low academic achievement were found respectively to possess high, average and low science attitude.

Bandyopadhyay, J. (1984) in the study '*environmental influence, academic achievement and scientific aptitude as determinants of adolescents' attitude towards science stream'* found that pupils with high positive attitude towards science differed significantly from those who possessed negative attitude towards science with respect to independent factors of environmental influence measured by parental education, income and SES, influence of teachers and peers and scientific aptitude measured by numerical ability, mechanical reasoning and space relations.

Yager & Yager (1985)in their study '*changes in perceptions of science for third, seventh, and eleventh grade students*' found negative attitudes of students toward science increase by grade level and students' interest in science starts declining between third and seventh grade

Matyas, M.L. (1985)in the study '*factors affecting female achievement and interest in science and in scientific careers* 'found that problem of negative attitude toward science is more in women. Fewer women are enrolled in science classes than men.

Ghosh, S.(1986) in *'a critical study of scientific attitude and aptitude of the students and determination of some determinants of scientific aptitude'* found that scientific aptitude of students had a positive relationship with scientific attitude and also that academic motivation, scientific attitude and academic motivation were positively correlated. The scores in scientific aptitude test could be predicted from scores in scientific attitude, academic motivation and SES of parents through multiple regression equation. It was found that students having high scientific attitude were superior to those having low scientific attitude. SES of students in urban areas was positively related to their scientific aptitude, however no such relationship was found in rural areas.

Patnaik, B.K.(1986) in his study *the scientific temper _ an empirical study* tried to trace the history of the construct scientific temper and gave a very consolidated picture in terms of landmark events happening after the conception of its idea by Pandit Jawahar Lal Nehru. He emphasized on some fundamentals of scientific temper which were: A passion for facts; Cautiousness of statements; Clearness of vision and Sense of interrelatedness of things. He presented a number of constituents of scientific temper which were Scientific method; Logic and the spirit of inquiry; The universal formula for causal investigation; The unfolding and tentativeness of science; Rationality; Objectivity; Humanism; Disenchanting religion; Reformism and secularism; Alternative rationality; Creating the best of human environments; The ideology of science; Norms in Science; Universalism; Communism; Disinterestedness; Organized scepticism; Consistency; Values: originality and creativity; Explanation; Falsifiability; Self criticism; Simplicity and Inter-subjectivity. Finally he tried to define the difficult concept of Scientific Temper by finding the inter-relatedness between all its constituents as a much needed value system required for the development as well as security of the nation. He further tried to empirically test the construct on the post graduate students representing 32 departments. It was found that there was no definite, conclusive and significant relationship between scientific information and scientific temper across the disciplines of science and

humanities, which means only being scientifically aware does not guarantees scientific temper. It was also found that modernity is the principal, if not the only predicator of scientific temper and there was an inverse association between scientific temper and religious faith.

Mandila, S.S. (1988) in the study '*attitudes of secondary stage students towards science curriculum and its relationship with achievement-motivation'*found thatattitudes of secondary stage students towards the science curriculum were favorable and had a relationship with their achievement motivation.

Srivastava, M. (1988)in *an investigation into the scientific aptitude of higher secondary science students in relation to their cognitive style* tried to find the relation between science aptitude of secondary school students and their cognitive styles and found that there was a significant sex difference only the aspect of 'dogmatism'.

Ghosh. Shibani.(1989) in *a critical study of scientific attitude and aptitude of the students and determination of some determinants of scientific attitude* showed that whereas scientific aptitude was related to scientific attitude, there were no such significant differences with respect to sex, socio-economic status and place of work among various group.

Sharma, M.K.(1990)in *a study of scientific literacy, attitudes towards science and personality traits of students and teachers* found that students and teachers with sound scientific literacy possess positive attitude towards science.

Kumar,U.S.(1991) On the basis of the study titled *the teaching of general science and the development of scientific attitude in secondary school students in relation to achievement in general science* reported that the development of scientific attitudes depended upon the perception of students towards science teaching and nature of learning experiences.

Malviya, D.S. (1991) in *a study of attitude towards science and interest in science of school going adolescents* showed that high scores on attitudes towards science favour higher scientific interest with no major differences with respect to age, sex, profession and socio economic status.

Kumar, M.S.G.(1991)in the study named '*effect of intelligence, achievement (biology) and extraversion on the questioning ability of standard IX pupils in biology'* found that factors like intelligence, achievement in biology and extraversion influence the levels and number of questions asked by the students.

Dubey, K.K.(1992)in *a study of the scientific temper and its measurement*concluded that all groups of students exhibited a degree of scientific temper with no differences but a significant level of differences were observed between male and female science teachers.

Nellaippan, N.O.(1992) in *a study of scientific attitude and interests among higher secondary biology students in relation to their learning environment*examined both attitude and interest within the context of learning environment and showed that various components of the learning environment are significantly related to both scientific attitudes and interests whereas sex and locality of students do not influence their scientific attitude and scientific interests.

Sood, J.K. (1992) in his study *the public understanding of science* on students and teachers revealed a significant relationship between the public understanding of science and attitudes towards science. Significantdifferences with respect to sex were observed in both the variables.

Koballa, T.R. (1995) in the study 'childrens' attitudes towards learning science' reported that that children's attitudes towards school science appear to become less positive as they progress through early stages of schooling, and become even less positive as they move on to higher levels which remains unclear.

Rani, S.D. (1997)in *a study of problems of science education and attitude of students towards science in higher schools of East Khasi Hills district of Meghalaya*tried to examine the problems faced by high school students and revealed that government should take adequate steps for the appointment of regular qualified and trained science teachers. Also there should be adequate teachers for teaching physical and biological sciences separately. A well co-ordinated plan of in-service training should be regularly conducted to improve the quality of science education in high schools and initiatives are to be taken for nurturing the favourable attitude towards science within students by incorporating positive emotions, popularizing science through science clubs, fairs, exhibitions, library usage and adopting explorative mode of teaching science subject.

Singh, B.(1998) in his study *a study of scientific temper in relation to personality and environment* found that there is a significant low positive relationship between the extraversion trait of personality and scientific temper. It was also found that there is a significant low negative relationship between introversion/ neuroticism trait of personality and scientific temper.

Papanastasiou, E.C. & Zembylas, M. (2002)in their study of*the effect of attitudes on science achievement: a study conducted among high school pupils in Cyprus*tried toexplore the attitude-achievementrelationship. Investigation revealed that different components of science-related attitudes are differentially relatedto science achievement. The study came up with a Cyprus model explaining 16.4 per cent of the student's science achievement and 27.3 per cent of the variance of the student's attitudes on science.

Suchitra, K. (2004) in her study named *classroom learning environment and select affective variables in relation to achievement in physical science of students of single - sex and coeducational secondary schools* used three main independent affective variables namely achievement motivation, self-esteem and attitudes (towards science and academic work) and some demographic variable of sex, school types and school environment in order to find the relationship with the main dependent variable of achievement in physical science of secondary school students. It was revealed that only self-esteem, attitude towards science and attitude towards academic work had significant main effect on the achievement in physical science. Gender differences in attitudes were found in single-sex schools but no differences were visible in co-educational schools. With regard to achievement in physical science, gender differences were found in both the school types. In single-sex schools boys' mean achievement was greater than that of girls but it was exactly opposite in case of co-educational schools.

Bhatnagar, R.D.(2014) in *an investigation into the scientific temper in relation to scientific creativity of senior secondary science students*found that the dimension of scientific temper namely scientific information, free from superstition, cause finding ability and curiosity were not significantly different(0.01 level of significance) for PCM and PCB group students but were found significantly different (0.01 level of significance) for the sub dimensions logical and

reasoning ability and problem solving ability where PCM students' mean score was found more than the PCB students. As far as the scientific creativity was concerned which was measured under three dimensions-fluency, flexibility and originality, both the groups did not differed significantly (0.05 level of significance). Also correlational analysis was performed between scientific temper and scientific creativity scores of students and it was found that there is no significant correlation. However, a very low positive but significant correlation was found between the scientific temper dimensionsof scientific information and scientific creativity; logical and reasoning ability and scientific creativity; and cause finding ability and scientific creativity.

Bhat & Netragaonkar (2014)in their study *scientific temper and academic achievement of first and non-first generation learners in Kashmir*tried to compare the scientific temper of the first and non-first generation learners using the scientific temper scale of Wani, S. R., & Nadeem, N. A. (2010) and found that the non-first generation learners possessed an overall better scientific temper and academic achievement than the first generation learners. They were found significantly better on the objectivity, rationality and aversion to superstitions dimensions of the scale but they did not differed significantly on the curiosity and open-mindedness dimensions of the scale.

Joshua. E. (2015) in her study name *effectiveness of a scientific temper package on certain cognitive and affective variables of students at secondary level*designed a Scientific Temper Package (STP) and experimentally tested its efficiency on certain cognitive and affective variables of the secondary school students.The cognitive variables comprised of self-regulation, achievement in biology and scientific creativity and affective variables comprised of scientific temper, social sensitivity and science interest. The instruction based package comprised of six components viz. scientific literacy, attitude, thinking, method, perception and habit which tried to cover the knowledge, attitude and skill or practice component of scientific temper. The initial perception of secondary school teachers revealed that there is low level of scientific temper in students such that boys, rural school students and aided school students possessed higher level of scientific temper than their counterparts. It was also observed that students improved on their scientific temper after the intervention of STP compared to students taught through activity oriented method. All the studied variables i.e. achievement in biology at all the levels of cognitive domain, self-regulation and scientific creativity, science interest and social sensitivity got significantly enhanced due to STP.

Kour, S. (2015) in her study *scientific temper among academically high and low achieving adolescent girls* found that high achieving adolescent girls possessed more scientific temper than the low achieving adolescent girls. The two groups differed significantly on curiosity, objectivity and rationality dimensions of the scale but did not differed significantly on the open mindedness and aversion to superstitions dimensions of scientific temper.

Andrabi,**A.A.(2015)** in his study *scientific temper, emotional intelligence, SES and academic achievement among tribal and nontribal adolescents of Kashmir*found that non-tribal adolescents of Kashmir have higher level of scientific temper, emotional intelligence, SES and academic

achievement than tribal adolescents of Kashmir. Correlational analysis was performed and it was found that scientific temper and academic achievement reveals a positive correlational coefficient of 0.19 for the total sample; emotional intelligence and academic achievement reveals a positive correlational coefficient of 0.13 for the total sample; SES and academic achievement reveals a positive correlational coefficient of 0.27 for the total sample. All the values were found significant at 0.01 levels.

Nautiyal, R. (2018)in *a study of the relationship of teacher education program with scientific temper and attitude towards creative teaching of prospective teachers in relation to some selected variable* found that there was significant observed differences in the level of scientific temper for the entire sample (0.05 level of significance) after the intervention program of teachers' training. However, no differences were significantly observed within science students unlike arts students differed. It suggested that the intervention program of teachers' training was not as effective for science students as it was effective for arts students. Also attitudes towards creative teaching differed between entry and exit levels of training program.

2.2.3 Studies on Achievement Motivation and Science Motivation

Students' motivation for performing higher in the academic subjects positively influences their academic achievement. Similarly a measure of students' science motivation levels can predict their performance in science subject.Some studies on the effect of achievement motivation (n-achievement) on academic achievement have been documented in Indian studies but a very handful of them targets achievement in science exclusively. With the beginning of 21st century research specifically onthe construct of 'science motivation' began to be explored in many western contexts revealing its importance in promoting science educationbut so far no such attempt has been made in India in spite of availability of standardized tools that can measure students' level of science motivation. Following are some the reviewed studies collected under thisaffective construct:

Mehta, P., Kumar, K., Sharma, B. and Kanade, H.M.(1967)in their study on *level of n-achievement in high school boys*showed that their n-achievement scores showed a highly significant relationship with marks in English, Mathematics and with total marks. It has a high positive relationship with marks in Science subjects and marks in Hindi and non-science subjects. The n-achievement also shows positive correlation with intelligence.

Bhatia, D. R.(1968)constructed *a test for measuring achievement motivation*of students and tested the hypothesis that the students with high achievement motivation shall achieve better than those who are less motivated. The test was found to be highly reliable and valid.

Tamhankar, V.S.(1968)in *a study of achievement motivation among young adolescent boys in Poona city*also limited itself to boys of high schools and attempted to relate the behavioural state of adolescent boys with their n-achievement. It was found that the relaxed condition represents a significantly lower level of achievement motivation than the neutral condition, but the arousal condition does not present a higher degree of n-achievement than the neutral condition (the mean n-achievement score under aroused condition was even lower than the relaxed condition). The n-

achievement is positively and significantly related to theoretical value, but negatively and significantly to aesthetic value and not related to age. The n-achievement of boys has a low positive correlation with their intelligence and academic performance.

Rabindradas, L.D.(1969) in *a study of personality rigidity in relation to motivation, learning, concept formation and perception*tried to study the interaction of motivation of learners with their learning abilities. A special nomenclature of high and low rigid individuals was given to distinguish high and low motivational aspects within learners. It was found that the high rigid (choice tendency of an individual to adhere to type of behaviour or set developed by him) individuals show less variable behaviour in goal setting tasks than the relatively less rigid individuals and adhere to clues in the concept formation task significantly better than others. The overall picture of the results shows that the rigid individual exhibits a distinct pattern of behaviour in the different task situations and is consistently superior in conceptual thinking to the less rigid individuals.

Mehta, P.(1969)in yet another unisex comparative study named *the achievement motive in high school boys* found that the n-achievement level of boys in Delhi is higher than that in Madras and it is comparable with teenage boys in Germany and USA, but it is lower than that of Brazilian and Japanese boys. The n-achievement showed positive correlation with the total performance at the school examination.

Chaudhary, N.(1971)in a study titled *the relationship between achievement motivation and anxiety, intelligence, sex, social class and vocational aspirations* attempted to find the relationship between achievement motivation and intelligence on one hand and achievement motivation and anxiety levels of students on the other hand. The scores indicated that girls have higher n-achievement score. It was found that the correlation coefficients between n-achievement and intelligence scores for combined samples, and for boys were not significant, whereas the same was significant at .01 level for girls. Partial and multiple correlation revealed that there was absence of relationship between these two variables. The correlation between n-achievement and test anxiety was negative but not significant.

Desai, D.B.(1971) *Achievement motivation in high school Pupils in Kaira district*

This was a comprehensive study covering multiple variables. But the main highlight of the study was the study of relationship between intelligence and n-achievement. It was found that there was a definite positive correlation between IQ and n-achievement scores. It was observed that n-achievement score increases with IQ. Feeble minded pupils had 2.1, average 6.8, very superior 10.9 and genius 13.4 as mean n-achievement score.

Desai, D.B. and Trivedi, R.S.(1972)in their study of *achievement motivation development in high school pupils through implementation of specially designed curriculum*tried toexperimental study a new self-designed curriculum on high school students and assessed its influence on their n-achievement. It was found that there was a total gain of 10.4 (15.7-5.3) in mean achievement score as a result of treatment. The gain of the pupil in english and geography subjects revealed a positive impact of the new curriculum. This lead to the prediction that by the implementation of proper system, incentives and healthy classroom climate can improve the performance of students

Gokulnathan, P.P.(1972) through *a study of achievement related motivation (n-achievement and anxiety) and educational achievement among secondary school pupils*did a comparative study of n-achievement with respect to demographic factors revealing that the tribal pupils obtain

significantly higher n-achievement scores than the non-tribal pupils. Also, the girls have an overall significantly higher n-achievement than boys.

Paul, A. (1981)did *a study of certain motivational aspects of goal behaviour of students in the vocational and academic spectrums of the higher secondary pattern of schooling* \ studying six goal related aspects of secondary school students. The vocational spectrum students(students from engineering, commerce and agriculture) had significantly higher mean scores in goal aspiration, perception, locus of control and in scholastic achievement whereas the academic spectrum students(students from humanities and science groups) had significantly higher mean scores on goal risk behaviour. It was found that in academic spectrum students differed significantly in the perception of future goals, school goal relevance, goal phantasy and goal locus of control. In the vocational spectrum the engineering students differed in goal perception from commerce students and in their goal phantasy from both the other groups. The six goals related variables explained 31.4 % of variance in the scholastic achievement of academic spectrum group and 73.1% of variance for vocational spectrum group.

Tuan, Chin, & Shieh (2005) developed a questionnaire that measures students' motivation toward science learning (SMTSL) with six scales of self-efficacy, active learning strategies, science learning value, performance goal, achievement goal, and learning environment stimulation. 1407 junior high school students from central Taiwan were selected by stratified random sampling to respond to the questionnaire. High motivators and low motivators showed a significant difference ($p < 0.01$) on their SMTSL scores.

Glynn, S. M., Brickman, P., Armstrong, N., & Taasoobshirazi, G. (2011) *Science motivation questionnaire II: Validation with science majors and nonscience majors*

This studytried to measure the science motivation using Science Motivation Questionnaire II (SMQ II) of science majors and nonscience majors in American undergraduate students in order to assess the differences in the motivation to learn sciences. The SMQ(II) assessed five motivation components: intrinsic motivation, self-determination, self-efficacy, career motivation, and grade motivation. It was reported that the science majors were better on all the components of science motivation and in both science majors and nonscience majors, men had higher self-efficacy than women, and women had higher self-determination than men. This suggested that science motivation differs with the background i.e., their preference to choose science as major or non-major subject at undergraduate level and also on some dimensions with respect to gender.

Bryan, R. R., Glynn, S. M., & Kittleson, J. M. (2011) *Motivation, achievement, and advanced placement intent of high school students learning science*

This study made use of the social cognitive theory framework to assess the motivation of school students (14-16 years old) to learn science in their introductory science courses and how does it effect their achievement. The students were assessed on their intrinsic motivation, self-efficacy, and self-determination. Individual interviews were taken with the representative sample of the students and all students were asked to write essays about their motivation. It was found that students' intrinsic motivation, self-efficacy, self-determination, and achievement were related and self-efficacy was most related factor. This was found consistent with the social cognitive theory. The Advanced Placement Program (APP) aspirants were higher than non-aspirants on all the

factors and achievement. The educational implication of the study was immense as it was analyzed through student response patterns that factors such as inspiring teachers, career interests, and collaborative-learning activities were regarded as strong motivators and hence science teachers should use modeling and collaborative-learning activities to foster students' motivation and achievement and interest in science.

Chumbley, S. B., Haynes, J. C., & Stofer, K. A. (2015)*)*in their study *a measure of students' motivation to learn science through agricultural STEM emphasis*tried to find what kind of motivation towards learning agriscience is held by the secondary agriculture students. The study used a modified version of the Science Motivation Questionnaire II (SMQ II) and applied descriptive-correlational research design for the same. It was found that students possessed moderate levels of motivation towards agriscience as a whole. The most powerful motivating constructs were found to be grade motivation and self-efficacy and least motivating construct was that of self-determination. No significant correlations were found between gender or grades and motivation to learn science. Females were found to possess higher motivation within self determination and grade motivation over males.

Salta, K., & Koulougliotis, D. (2015) did a study *assessing motivation to learn chemistry: adaptation and validation of science motivation questionnaire II with Greek secondary school students*by adapting Science Motivation Questionnaire II (SMQ II)to make the Greek version of Chemistry Motivation Questionnaire II (Greek CMQ II) to investigate Greek secondary school students' motivation to learn chemistry for the first time. 330 secondary students (163 boys and 167 girls) belonging to lower (14-15 years) and higher secondary schools (16-17 years) were chosen for the study. Gender based comparisons showed that girls had higher self-determination than boys in both the age groups and also the girls of lower secondary groups had higher career and intrinsic motivation than the boys of the same age group.

Chan Y. L. & Norlizah C.H.(2017)*Students' Motivation towards Science Learning and Students' Science Achievement*

This study in Malaysia tried to assess the level of secondary school students' motivation towards science learning and science achievement identifying the gender differences in motivation level.The results revealed that the motivation level of the students towards science learning was at moderate level and the science achievement level was between averages to low. The female students were found to be significantly more motivated than the boys. The results also indicated that students' motivation towards science learning has a significant correlation with students' science achievement ($r = .354^*$, $r^2 = .125$, $p = .000$).

2.2.4 Studies on Academic Anxiety and Science Anxiety

In India few studies on academic anxiety have been done in relation to academic achievement, especially test anxiety. However no study specifically on science anxiety has been reported in India. Mallow, J.V. coined the term "science anxiety" in 1977, which he identified and defined as, 'a debilitating interaction of emotions (fear) and cognition (science learning).' Since then studies on science anxiety have been tried outside India and the research findings hold a valuable

educational implication for teaching-learning situations of science subject. Sadly the research review in the country suggests that this phenomenon has not been addressed seriously in terms of studies trying to understand it. Following are some of the reviewed studies related to these constructs:

Julka, G.L.(1963) *Aggression, fear and anxiety in children-(their educational implications)*
In this comparative study it was tried to study the various themes emerging in the minds of children in relation to fear, aggression and anxiety amongst the tribal and nontribal children. It was found that fear themes occurred more frequently in the records of children than the other themes. This was true in case of all children –Bhils and non-Bhils, males and females. Next in order of frequency were the themes of aggression and anxiety. The most common forms of fear expressed by the children were fear of wild animals, fear relating to punishment or scolding by the teacher for not doing homework or getting late in the class; the most common forms of aggressive responses were verbal forms of aggression such as rebuking, scolding, complaining etc. Children's anxieties were mostly related to their school work. A few children had also expressed their worries relating to health of their own self or physical wellbeing of their family members. The non Bhil-children produced significantly more themes of aggression then the Bhil children.

Sharma, S.(1968) *Relationship of self-concepts with anxiety and school achievement of adolescents*
The study investigated the relationship of self-concept (two measures: positive / negative self-concepts; and self-ideal discrepancies) and general anxiety with school achievement of class X students of 4 Indian states. It was found that the value of 'r' between self-concept scores (positive / negative dimensions) and self-ideal discrepancy scores was -0.80which was highly significant holding a negative relationship. The value of 'r' for self-concept scores and anxiety scores was -0.51 and the value of 'r' for self-ideal discrepancy scores and anxiety scores was -0.50. These values denoted a significant linear relationship between two measures of self-concepts and anxiety. Subjects with negative self-concept (or high self-ideal discrepancy) were significantly more anxious than subjects with positive self-concept (or low self-ideal discrepancy). Both self-concept and self-ideal discrepancy scores were curvilinearly related to school achievement.

Pandit, K.L.(1969)*The role of anxiety in learning and academic achievement of children*
This unisex study was done on school boys of grade V in one elementary school in Delhi. The major finding of the study was that anxiety bore a negative relationship with learning and academic achievement. Children having less anxiety were found superior in learning and achievement, irrespective of the task difficulty, to those having more anxiety. However, high achievers were more anxious than low achievers in motivating content situations. Interestingly, when anxiety was experimentally induced the lowest anxiety group showed a significant improvement in achievement in the retest, while the highest anxiety group showed poor performance in the retest. Subjects with low intelligence and high anxiety failed to improve in achievement to a desired level due to induced anxiety as it interfered with the retention of learning.

Verma, P. (1973) *The effect of anxiety, task difficulty, and reinforcement on paired associate learning at three levels of intelligence*

The study made use of factorial design of (2x3x3) with two groups of anxiety (HA & LA), three reinforcement conditions (praise, reproof and praise plus reproof) and three levels of intelligence (high, middle and low) for each of the tasks (easy and difficult).The study revealed that on the easy task, significant anxiety and intelligence interaction showed that anxiety facilitated learning of subjects belonging to upper and middle levels of intelligence, and the results were not significant at lower level of intelligence Further on the difficult task, significant anxiety and intelligence interaction revealed that difference between the performance of HA and LA subjects were not significant at upper and middle levels of intelligence, whereas anxiety impaired learning at lower level of intelligence.

Rai, P.N. (1974)in *a comparative study of a few differential personality correlates of low and high achievers*of biology group students at higher secondary schools found that anxiety as a personality trait had a changing role in scholastic achievement such that low level of anxiety helped in achieving high, whereas very high level of anxiety was detrimental to achievement. Level of aspiration was not a significant correlate of achievement but it was desirable that students fixed up high goals commensurate with their ability and tried to achieve it. Low goal setting was in no way desirable characteristics for better achievement. The n-achievement is a prerequisite for better achievement.

Jaiswal, K. (1980)in*a study of anxiety, frustration and adjustment patterns of girl students at graduation level and their educational implications* found that the educational achievement of low anxiety group of girls was high as compared to high anxiety group girls. Although, there was no significant relationship between frustration level and educational achievement but there was a significant relationship between adjustment, anxiety and frustration. Even the well adjusted and mal-adjusted students did not differed significantly on the achievements. Girls belonging to Science group were found to possess both more anxiety and adjustment ability than those belonging to humanities group.

Khattari, S.(1982) in a study named *a comparison of behavioural strategies for reducing examination anxiety in girls* sampled top 25 % graduate females from different colleges and universities of Varanasi for high anxiety group. This sample was then divided into 4 groups for experimental study. It was shown that group relaxation, systematic desensitization and counselling technique were helpful in reducing examination anxiety as compared to the control group. The group systematic desensitization technique was the most effective technique of all the techniques in bringing down examination anxiety.

Chiarelott & Czerniak (1984)*Science Anxiety: An Investigation of Science achievement, sex and grade level factors*

In this study the researchers found that children as early as third grade, exhibit anxiety toward science and females, as early as third grade, exhibit more anxiety than their male counterparts. They found in their research that (a) science anxiety was correlated with science achievement ; (b) science anxiety was gender-related; (c) science anxiety emerged early in a student's exposure

to science curriculum; (d) elementary teachers felt generally unprepared to teach science, and (e) teachers' attitudes correlated with their science anxiety.

Yurkewicz, W. (1988)in his study *the relationships among teacher behaviors, science anxiety, and success*examined the perceptions of 1622 science students from 86 secondary classes and found that student' perceptions of teacher behaviors such as expectation clarity, elitism, and instructional difficulty were related to pupil science anxiety.

Kastrup, H. & Mallow, V. J. (2016*) Student attitudes, student anxieties and how to address them*
This bi-national study on Danish and American students found that females in the non-science groups had significantly higher anxiety than males. However, students irrespective of gender or field of study expressed strong negative attitude towards science. Their study raised many questions on contemporary practices of imparting and doing science which leads to science anxiety. Their submission is to turn the table using a learner friendly approach, where learners are constructing science experience in multiple perspectives.

2.2.5 Studies on Emotional Stability and Emotions

Very few studies could be documented covering the aspect of emotional stability/ maturity in India and no study was conducted for understanding the relationship between learners' emotional stability and science achievement. As far as western studies are concerned a lot of studies in context of emotions (affect) and their role in science education has been a prime focus area of research since 1980s. Following are some of the reviewed studies under this construct:

Lal, K. (1968)*A comparative study of emotional stability of mentally superior and average adolescents*
This was a comparative study to address the importance of emotions in achievement of students. Here it was found that the superior pupils had a slightly better tendency towards adjustment in general but the difference was not significant. At 14+ and 15+ the superior pupils were better adjusted whereas at 16+ the average group was better adjusted. While emotional stability increased with age in the superior group, it deteriorated with age in the average group. Both groups were ruled by immediate need of gratification, but the superior group was ruled to a lesser degree but the average group showed a more withdrawing type of behavior.

Pandey, P.N. (1982) *Development of an emotional maturity scale*
In the study an attempt was made to develop an emotional maturity scale within the paradigm framework given by C.E. Izard. The verbal emotional maturity scale modified slightly modified and tried to measure emotional maturity under nine fundamental dimensions. It was eventually found that the scale was able to discriminate between different levels of emotional maturity and in turn also suggested that emotional maturity improves with age and experience as the teachers in the sample population was found to be more emotionally mature compared to the students.

Watts, M., & Alsop, S. (1997)*A feeling for learning: modelling affective learning in school science*

In their series of empirical studies the researchers explored nature of learners' understanding, their identification with science and scientific issues and their reactions to 'radiation and radioactivity' topics within science. Their study revealed that science concepts should be taught in such a way that they seem agreeable to mind or palatable; where they found evidence after interviewing students that unpalatable concepts undergo 'conceptual avoidance'. They argued that the conceptual change view of learning is as much dependent on the affective domain as much as on the cognitive.

Pekrun, R., Goetz, T., Titz, W. &Perry, R.P.(2002)*Academic Emotions in Students' Self-Regulated Learning and Achievement: A Program of Qualitative and Quantitative Research*

In this extensive qualitative study it was found that students experience a rich diversity of academic emotion. But their research review confirmed that academic emotions have largely been neglected with an exception of test anxiety. They developed an Academic Emotions Questionnaire (AEQ) and it was tested in 7 cross-sectional, 3 longitudinal, and 1 diary study using samples of university and school students. The findings of the study confirmed that academic emotions are significantly related to students' academic achievement, motivation, learning strategies, cognitive resources and self-regulation. Hence the importance emotions cannot be undermined in educating children.

Subramanyam(2007) *Academic achievement in relation to emotional intelligence, locus of control and study skills of high school students*

In this study it was found that there is significant interaction among emotional intelligence, locus of control, and study skills with regard to academic achievement of high school students.

Abrahams (2009) *Does practical work really motivate? A study of the affective value of practical work in secondary school science*

Through his study it was suggested that there are affective components in doing science along with cognitive.

Brígido, M., Couso, D., Gutiérrez, C., & Mellado, V. (2013) *The emotions about teaching and learning science: a study of prospective primary teachers in three Spanish universities*

In this descriptive and comparative study it was found that the prospective teachers felt positive emotions towards learning subjects of Geology/ Biology and negative towards learning subjects of Physics/ Chemistry when they recalled their secondary school days but they expected in their future teaching positive emotions will increase and negative emotions will decrease than they used to feel at secondary school levels. They suggested that in science education affective aspect should be given importance at par with cognitive.

2.3 Studies on Science Education in Mizoram

With the establishment Science Promotion Wing under the aegis of Directorate of Education, Mizoram in 1988, some concrete measures in the path of improving science education in the state were undertaken. Historically speaking science and mathematics education was not in a pleasant form until Government of India tried to reorganize the education system prevailing in the state to enhance enrolment, retention, participation and achievement in science education

across all the levels of education. A very handful of researches have been done since 1986, in order to assess the status of science education in the state. Before 1985, Mizoram was a union territory of India. Following are few of those studies:

Darchhingpuii (1982)in *a study of science achievement and science attitudes among male and female college students in Mizoram* found that science interest was positively related with science attitude and the male students possessed more favorable attitude towards science than female college students which was found significant at 0.01 level. The study also surveyed that there were only two colleges offering science subject (PUC and Zirtri) only in the capital district of Aizawl with scarcity of science teachers which was a disheartening situation. It was reported that with the of late efforts of government, to establish the Science Promotion Wing in 1973, the students' attitudes towards science subjects have considerably improved over the past and there was a rise in interest to take up sciences at tertiary level.

Darchingpuii (1989) in her *study of science achievement, science attitude and problem-solving ability among the secondary school students in Aizawl* confirmed that socio-economic status, type of school attended, family facility (opportunity structure), scientific attitude and problem solving favoured students' achievement in science. This study was first comprehensive study on science achievement where an attempt was made to examine the problem solving ability among the secondary school students and analyzed its relation to achievement and attitude towards science.

Sailo, L. (1982) *Affective correlates of achievement motivation among high school students in Aizawl*

The study found that high school students studying in deficit schools (unaided self-financed schools) were observed to possess more motivation compared to government schools even with better staff equipments and facilities.

Thanhawla (1983)*An investigation into the causes of failure in science and mathematics in high school leaving certificate examination in Mizoram*

Through the study it wasfound that the students' performance is much better in deficit schools (unaided self-financed schools) than the government schools with regard to their school leaving certificate examination results.

Lalduhsanga, J. (1983) in *a study of personality factor pattern of low, normal and high achievers in secondary school science*tried to identify unique personality associated with different achievement levels in science at secondary school level. Science Achievement Test (SAT) was constructed for the purpose. It was found that both high and moderate achievers were more outgoing, intelligent, emotionally stable, assertive, conscientious, tough minded and self sufficient than the low achievers except for the moderate achievers who were found to be more tensed than the low achievers. On the similar line the high achievers were found to be more outgoing, intelligent, emotionally stable, phlegmatic and group dependent than the normal achievers.

Sudhir, M.A. & Muralidharan Pillai, P.G.(1987)in their study on *science achievement in relation to intelligence and socio-economic status: a study of secondary school students in*

Aizawl found that science achievement varied both with respect to intelligence and SES. Students with high intelligence performed better than the students with low intelligence levels. A similar pattern was observed for the factor SES, wherein students belonging to high SES performed better in science than those belonging to low SES group.

Zohmingliani, L. (2012) in her *study critical study on thestatus of science education in Mizoram*extensively studied all the levels of education in Mizoram. The study revealed that first high school was established in Mizoram in the year 1945 at Aizawl and by the period of 1972 when Mizoram became one of the union territories of India, there were 70 high schools all offering science education. When Mizoram gained statehood in 1986 the number rose to 154. As on September, 2009 there were 521 high schools in the state, 27 higher secondary institutions offering science and 6 government colleges in whole state offering science as a subject. The research also investigated several qualitative parameters like the status of science laboratories, academic profiles of science teachers at all the levels of education and students perceptions towards science education. It was revealed that science education is not occupying a central position particularly at elementary and secondary years of students resulting into students' obligatory withdrawal from the subject by the time they reach higher secondary level of education. This resulted in decreased enrollment of students both at higher secondary and higher levels of education.

2.4 Implications of the Review of Literature for the Present Study

The studies cited above have rightly addressed the role of various psychological affective level constructs but still there are negligible studies to address their role in science achievement and science education. The psychological constructs of affective domain have been not explored to maximum in the area of science education particularly in context of our country, with a very handful of studies to be mentioned in this potential area. On the contrary, review of the western literature suggests that terms like science motivation, science anxiety were coined for their existence in early by 1980s and exclusively researched for understanding the psyche of learner while doing sciences of various types.A comparative analysis of studies done so far with regard to scientific temper and science attitude reveals that there are relatively fewer studies on scientific temper in relation to science achievement and much more focus in this regard is required. Especially studies abroad did not focuse on the construct of scientific temper but relatively greater number of studies explored the construct of scientific attitude. Further if we critically analyze the motivational studies (n-achievement) and science motivation studies, it implies that motivation as a construct has to be explored vigorously for its positive influence on science achievement and understanding. Sadly, in India no study has been done specifically in context of science motivation. An analysis of the various studies in the field of science anxiety suggests that there is no study done specifically addressing this phenomenon, however, some studies are addressing academic anxiety in general. With the increasing curricular load in sciences it becomes necessary to address the psychological wellbeing of the students along with their physiological wellbeing. It is evident that science anxiety sometime is contributed more

through the environmental factors than the intrinsic factors related to the students which justify the need of study on this specific phenomenon related to science.The role of emotions has been mostly in the compromised state when it comes to teaching-learning situations in science. In social sciences and languages, the role of affect has been always utilized and it is also very much in the character of these disciplines that affect finds an inbuilt composition in their delivery. But it is very sad that science as a discipline sometime becomes very hostile for students and they treat it as a dry discipline which is not the case. There is a serious need to change this notion and take the advantage of one's affect in making science teaching-learning experience more meaningful for both students and teachers. The review of literature provides a firm rational for the conduct of study focusing on the affective domain of the learner. The affective component in science education has been an untapped area which needs a beginning. The kind of studies so far undertaken in the state of Mizoram with special emphasis to science education guides the researcher to find a valid rational for the conduct of present study. Most of the studies conducted so far are state level surveys. The past studies have also indicated that students' achievement in science is not satisfactory in the state. Few studies on cognitive dimensions such as intelligence and socio-economic aspects but no study has been reported so far exclusively studying the affective aspect of learning sciences. Since students' achievement in science is a vital indicator for their success in future and also the development of state, the need of the present study is justified. Also, Mizo population is a unique homogenous ethnic and endemic population of the country and many of the personality traits of Mizo students remain unexplored, especially in context of understanding and doing sciences. Head (1989) predicted that the focus of research interest in science education would change so that the "affective area...will prove to be crucial in research and curriculum planning in the next decade." Head's prediction has already gained momentum and worldwide a new brigade of researcher has started producing evidence of relationship between affect and science. With that guiding thought the researcher chose the present study exclusively exploring the affective domain of students' through science related affective variables and understand their role in their achievement in science.

CHAPTER-3
METHODOLOGY AND PROCEDURE OF THE STUDY

METHODOLOGY AND PROCEDURE OF THE STUDY

3.0 Introduction

The methodology and the procedure involved in a study is perhaps its' backbone. A sound methodology plays a key role in finding valid and reliable findings which can benefit the process of knowledge expansion. It must be the prime concern of researcher that his/her findings should be authentic and trustworthy. The present chapter describes the methodology adopted by the researcher to find answers to the research question. The description of methodology comprises of following sections:

3.1 The choice of Research Paradigm
3.2 Method of Research
3.3 Population and Sample
3.4 Tools and Techniques of Research
3.5 Data Collection Procedure
3.6 Statistical Techniques employed in the Research

3.1 The choice of Research Paradigm

Selection of a Research Approach: The Quantitative vs. Qualitative paradigm: The kind of research problem one choose, decides the research paradigm of the study. The word paradigm relates to patterns of thought channelizing the research questions on encountering with a research problem. Even a same research problem can be taken in different perspective owing to the thought pattern of two different researchers. These paradigms thus guide and direct the whole process of research through the underlying philosophies. The research questions arise out of one's way of perceiving the reality. Research in Education is trying to understand social reality from the perspective of educational settings. The research methodologies can be divided into two major paradigms, logical –positivism and phenomenological inquiry (Best & Kahn, 1993). The 'objectivists' conception of reality directs to search and formulate universal truths just as they are formulated for physical world for its existence. There exists no boundaries between the physical world and social world and a similar methodology of research is employed. This objectivist's conception is popularly referred as the logical-postivism paradigm of research. A very contrasting 'subjectivists' conception is held by those who strongly believe that there are bifurcation in the physical reality, in which we exist and the social reality, which is result of our existence, we the humans. The two realities are not to be taken as same which the objectivists advocate. The term subjectivist highlights the subject or the individual or the humanistic perspective at the centre of research. These researches are based on a newer paradigm, namely the phenomenological enquiry paradigm. There are some fundamental differences between the two perspectives. The former believe that reality is independent of human existence. It exists irrespective of the fact that human exist. It existed before the human civilization and will continue to exist even after the extinction of civilization. On the contrary, the later views the reality through the lens of an observer who confirms its existence. Reality is not to be treated as independent of observer's view. Different observers can lead to multiple realities whereas the

objectivist argues for the existence of only one reality. Particular reality of specific truths is of stronger validity in subjectivist perspective than the universal reality or general truth which is the main focus of objectivist perspective.

3.2 Method of Research

A particular paradigm may be associated with certain methodologies (Chilisa &Kawulich, 2012). A positivistic paradigm strictly makes use of quantitative methodology, while a phenomenological paradigm utilizes a qualitative methodology. But this may not be strictly true for the latter case always. There are instances where one may use quantitative methodology occasionally on the demand of situational constructs in the constructive or interpretative inquiries falling under phenomenological paradigm. No one paradigmatic or theoretical framework is 'correct' and it is one's choice to determine one's own paradigmatic view and how it best relates to one's research design and provides the best answers to the questions of study (Chilisa &Kawulich, 2012). Relatively the importance of mixed approach methodology, using both quantitative and qualitative methodologies is of more significance than the use of single approach. The use of mixed methods finds its roots in triangulation of data which aims to enhance and strengthen research validity and credibility (Creswell, 2009). For example, using interviews as well as questionnaires add depth to the results that would not be possible using a single-strategy study, thereby increasing the validity and utility of the findings (Shah & Al-Bargi, 2013). It is always appreciable if the advantage of both the quantitative and qualitative methods can be hired through a research design.

Keeping the same approach in mind the researcher chose to use mixed approach methods employing majorly quantitative methods supported with qualitative inquiries. In general for this study *descriptive research design* has been used. Table 3.1 depicts the descriptive research design employed for the present research

Table 3.1
Diagrammatic Description of the Research Design

<table>
<tr><td rowspan="4">Variables of the Study</td><td>Dependent Variable (DV)</td><td colspan="4">Independent Variable (IV)
(Affective level variables relating to Science Subject)</td><td colspan="2">Groups</td></tr>
<tr><td rowspan="2">Science Achievement & Overall Academic Achievement

(HSLC science scores)</td><td>IV-1</td><td>IV-2</td><td>IV-3</td><td>IV-4</td><td>Achievement Levels</td><td>Demographic Variable Gender</td></tr>
<tr><td>Scientific temper (scores on Scientific Temper Scale)</td><td>Science motivation (scores on Science Motivation Questionnaire)</td><td>Science anxiety (scores on Science Anxiety Questionnaire)</td><td>Emotional stability (scores on Emotional Stability Scale)</td><td>High achievers (upper 27%)</td><td>Boys</td></tr>
<tr><td rowspan="3">Treatment</td><td rowspan="2">Compare with respect to gender</td><td>Compare with respect to level of achievement (high and low achievers)</td><td>Compare with respect to level of achievement (high and low achievers)</td><td>Compare with respect to level of achievement (high and low achievers)</td><td>Compare with respect to level of achievement (high and low achievers)</td><td rowspan="2">Low achievers (lower 27%)</td><td rowspan="2">Girls</td></tr>
<tr><td>Compare with respect to gender (boys and girls)</td><td>Compare with respect to gender (boys and girls)</td><td>Compare with respect to gender (boys and girls)</td><td>Compare with respect to gender (boys and girls)</td></tr>
<tr><td>Correlate IVs with DV</td><td>DV with IV-1</td><td>DV with IV-2</td><td>DV with IV-3</td><td>DV with IV-4</td><td colspan="2"></td></tr>
</table>

3.3 Population and Sample of investigation

3.3.1 Population

For the present study class X secondary school students of Aizawl district formed the target population. The choice of Aizawl district out of all the eight districts is justified in the fact that Aizawl being the capital district of Mizoram is representative of all other districts. Many students migrate to Aizawl for getting education since the educational facilities in their own district are inadequate. Also being the central hub of development Aizawl has the advantage of having all sections of society including small ethnic groups from all the parts of the state.

According to Annual publication on secondary schools, Directorate of School Education, Mizoram for the block year 2014-15 there are seven categories of secondary schools in whole of Mizoram and same holds true for Aizawl district. These categories are Central Government; State Government; Deficit; Adhoc Aided; Lumpsump Aided; RMSA and Private unaided schools. The central schools are affiliated to CBSE board and all the rest six categories of school are affiliated to state board, Mizoram Board of School Education (MBSE). It was decided that only state board students will form the population of the study. Hence, all the students studying in MBSE affiliated secondary schools were selected as the population of the study. According to the available data maximum share of high school students is owned by the Aizawl district. According to annual publication on secondary schools 2014-15 the percentage of State Government, Deficit, Adhoc aided, Lumpsum aided, RMSA, and Private schoolstudents in Aizawl was 37.09, 9.92, 13.13, 1.39, 1.75, and 36.69%respectively. The percentage of school types in parent population was kept in mind during the sampling procedure.Table 3.2 provides the number of students enrolled as on 30th September, 2014 in MBSE board schools in Aizawl district of Mizoram.

Table 3.2
Total Number of Students in Different Categories of Secondary Schools in Aizawl District Under MBSE

School Type	No. of Schools	Boys	Girls	Total	Percentage of students
State Govt.	66	2951	3211	6162	37.09%
Deficit	5	747	902	1649	9.92%
Adhoc aided	35	1015	1167	2182	13.13%
Lumpsum aided	4	112	120	232	1.39%
RMSA	14	139	152	291	1.75%
Private unaided	82	3101	2994	6095	36.69%
TOTAL	206	8065 (48.55%)	8546 (51.45%)	16611	~100% (99.97)

Source: Annual Publication 2014-2015

3.3.2 Sample

***a) Sampling Unit*:** High schools were chosen randomly as a sample unit while data collection. Each sampling unit became a student cluster of sample from where data was collected from the available secondary school students of class X.

***b) Sampling Design*:** Stratified random cluster sampling technique was used to pool out the sample. Only class X students from the secondary schools were chosen for sampling purpose as

they were supposed to appear for board examination and the science marks in their board examination was chosen as the parameter of performance in science. A total of 36 schools were visited for the collection of data in the block year of 2016-17. However, two schools were not included for final quantitative data analysis as there was no class X board exams in those schools for the particular block year. All the six categories of schools were visited according to the relative percentage in the population which was finalized using data from secondary sources. The school visits were finalized using data from annual publication according to which a total of 16611 high school Students (IX-X) in Mizoram. So roughly half of this total number could be projected as total population in class X in Mizoram where maximum share of students was from Aizawl district. Data on all the affective variables of study was obtained from all the 34 schools. A total of 1243 students were tabulated for their scores of board results in science and total marks obtained. Consequently it was found that some students either did not appear for board exams or were found defaulters and hence results of board were not declared. Upon discarding these students a final data of 1134 students was subjected to final analysis. There are 532 boys and 602 girls in existing data making 46.91% & 53.09% respectively which is similar to original population 48.55 & 51.45% respectively. The percentage of Government, Deficit, Adhoc aided, Lumpsum aided, RMSA and Private school students are 34.4, 10.23, 8.64, 7.76, 2.73 and 36.24% respectively which is approximately corresponding to the total percentage of students in different school types of Aizawl district as mentioned in annual data publication 2014-15.

The list of schools visited during data collection is attached vide **Appendix-1.**

Table 3.3 provides the number of students in the sampled schools of Aizawl district. A comparison of the Table 3.2 & Table 3.3 depicts that the sampled school are in similar proportion as represented in the parent population.

Table 3.3
Number of Sample Students taken from Different Categories of Secondary Schools in Aizawl District Under MBSE

School Type	No. of Schools	Boys	Girls	Total	Percentage of students
State Govt.	14	191	199	390	34.39%
Deficit	2	47	69	116	10.23%
Adhoc aided	4	37	61	98	8.64%
Lumpsum aided	2	38	50	88	7.76%
RMSA	2	15	16	31	2.73%
Private unaided	10	204	207	411	36.24%
TOTAL	34	532(46.91%)	602(53.09%)	1134	~100% (99.99)

Source: Field Data

c) Sample Size:

Sample size for the study of achievement in science and overall academic achievement; and level of scientific temper, science motivation, science anxiety and emotional stability were all the 1134 students of 34 secondary schools from Aizawl district.

d) Procedure Adopted for Classification of High and Low Achievers in Science:

For classification of selected sample students into high and low achievers the science achievement scores of all 1134 students was arranged in descending order and the top 27% were

taken as high achievers and bottom 27% were be taken as low achievers. Thus the size of the sample of high and low achievers in science became 306 top achievers and 306 bottom achievers making a total of 612 students.

e) Sources of Data

The present study has made use of both primary and secondary data. The primary data comprises of sample of class X students and secondary data comprised of data from annual publication on secondary schools, MBSE. The school visits were finalized using data from secondary sources.

f)Science Achievement Scores

The class X board results 2016-17 of the sampled population was procured through MBSE office to obtain their scores in science subject which was pre-decided as the parameter of their science achievement. This was also a secondary data.

3.4 Tools and Techniques of Research

A choice of right and relevant instruments and tools is must for gathering suitable and reliable data from the sampled population. For the present study the selection of the tools were done after a proper inspection of the tools related to affective variables of study. For the assessment of scientific temper of secondary school students, Scientific Temper Scale by Nadeem & Showkat (2008) was used. To have an understanding of Students' science motivation levels in the sampled population Science Motivation Questionnaire (SMQ) II by Glynn et al. (2011) was used. For assessing the science anxiety levels of the students an attempt was made to construct a questionnaire. The questionnaire was adapted from original Science Anxiety Questionnaire (SAQ) by Czerniak &Chiarelott(1984) with indigenous modification. The dimensions of original scale were also redefined. To have an assessment of emotional stability of the students a self constructed scale was used by the researcher after consulting relevant literature. The following sections provides the description of all the four instrument used for data collection.

3.4.1 Scientific Temper Scale by Nadeem and Showkat (2008)

The scientific temper scale constructed by Nadeem and Showkat (2008) assesses the scientific temper on five dimensions which are Curiosity, Open-Mindedness, Objectivity, Rationality and Aversion to Superstition. The scale comprises of 50 items with 10 items under each dimension in the same order as the dimensions are specified.

A) Operational definition of the dimensions:

i. ***Curiosity:*** The scale defines this dimension as a desire for understanding new situations that are not explained by the existing body of knowledge, seeking to find 'why' & 'how' of observed phenomenon and quest to look at usual things in an unusual way.

ii. ***Open-Mindedness:*** It is defined as one's willingness to revise opinions and conclusions in the light of evidences and facts and rejection of singular & rigid approach to people, things & ideas.

iii. ***Objectivity:*** This dimension is defined as demonstration of the greatest possible concern for observing and recording facts without any influence of personal pride, bias or ambition. It does not allow any change in interpreting results on the basis of present social, economic and political influence. Further it relates to ones' unwillingness to draw inferences and accept facts in the absence of sufficient evidence and convincing proof. Finally, it is reflected by one's ability of avoiding quick judgment based on mere opinions.

iv. ***Rationality:*** The dimension is defined as tendency to test traditional beliefs, acceptance of criticalness, identification of cause and effect relationship and challenge to authority.

v. ***Aversion to Superstition:*** It is defined as one's ability of rejecting false beliefs and acceptance of scientific facts and explanations.

B)Scoring:

The scale comprises of both positive and negative statements on which the respondent have to choose between a 3 point scale with options, 'Yes', 'Undecided' or 'No'. The scoring thus comprises of either a score of '1' or '0'. The scoring follows the following criteria:

a) For positive items: '1' for Yes and '0' for No.

b) For negative items: '0' for Yes and '1' for No.

c) For undecided option: '0'

C) Scoring Key

Table 3.4 provides the scoring key for the scale

Table 3.4
Scoring Key of the Scientific Temper Scale

	Dimension I (items 1-10)	**Dimension II (items 11-20)**	**Dimension III (items 21-30)**	**Dimension IV(items 31-40)**	**Dimension V (items 41-50)**
YES	1, 2, 3, 4, 6, 7, 8, 9, 10	11, 12, 13, 15, 18, 19	21, 22, 23, 24, 25, 26, 27, 29, 30	31, 33, 34, 35, 36, 37, 38, 40	43
NO	5	14, 16, 17, 20	28	32, 39	41, 42, 44, 45, 46, 47, 48, 49, 50

D) Norms

Table 3.5 provides the norms for the present scale

Table 3.5
Classification of Levels of Scientific Temper in the Scale

Range of Scores Classification	**Levels of Scientific Temper**
40 & above	High scientific temper
30-39	Above average scientific temper
20-29	Average scientific temper
10-19	Below average scientific temper
0-9	Poor scientific temper

E)Reliability

a) Test-Retest Reliability: On 100 samples the test-retest method was used with a one month's gap and the reliability was found to be 0.891.

b) Split Half Reliability: On 200 sample students of class IX and X the upper-lower half method and odd-even methods were employed to derive the split half reliability.

With former method the reliability was 0.761 and after applying Spearman Brown prophecy formula the reliability became 0.864.

With the later method the reliability was 0.791 and after applying Spearman Brown prophecy formula the reliability became 0.883.

c) The coefficient of correlation was also worked as per Kuder Richardson Formula No. 20 which came out to be 0.894.

Kuder Richardson Formula = $[n/n-1]\ [\sigma 2-\sum pq/\sigma 2] = .894$

No. 20 (N = 100)

F) Validity

a) Content Validity: It was based on the expert rating by selected judges.

b) Construct validity (N=200)

A 6 x 6 correlation matrix was worked out to indirectly measure the construct validity.

The results showed high, positive and significant correlation. Table 3.6 depicts the inter-correlation values between the dimensions of the scale.

Table 3.6

Inter-Correlation between the Dimensions of Scientific Temper

	CU	**OM**	**OB**	**RA**	**SU**	**TOTAL**
CU	*	0.40	0.29	0.38	0.40	0.58
OM		*	0.51	0.56	0.51	0.74
OB			*	0.84	0.73	0.87
RA				*	0.82	0.92
SU					*	0.88

All correlations shown above are significant at level 0.01.

c) Concurrent Validity

The correlation with standardized DN. Dani's scientific attitude scale (Vidya Bhawan, G. S. Teacher College, Udaipur) came out to be 0.791.

A sample of the Scientific Temper Scale is attached vide **Appendix 2.**

Dimension wise splitting of the Scientific Temper Scale is explained in **Appendix 3.**

3.4.2 Science Motivation Questionnaire (SMQ) II by Glynn, Brickman, Armstrong & Taasoobshirazi (2011)

The SMQ II is a revised version of SMQ (Glynn & Koballa, 2006). It was used to assess the science motivation level of secondary school students.

A) Operational definition of the construct:

According to Glynn & Koballa,*motivation to learn science*, a social cognitive construct is defined as an internal state that arouses, directs, and sustains science-learning behavior.

B)Sub-scales of SMQ II

The SMQ II has five subscales each with five items measuring the dimensions of **intrinsic motivation, self-determination, self-efficacy, career motivation and grade motivation.**

C)Scoring

The questionnaire comprises of 25 items where students respond to each item on a rating scale of temporal frequency: never (0), rarely (1), sometimes (2), often (3) or always (4).

The raw scores should be interpreted carefully since the scale is ordinal. The possible score range of the 5-item scales is 0-20 making a total score range of 0-100. The items were randomly ordered as provided in online version of SMQ II © 2011 Shawn M. Glynn, University of Georgia, USA.

Since SMQ II has been standardized on college students the score indicates what is "average" for undergraduate science majors and non-science majors at University of Georgia, it does not provide any classification criterion on the basis of obtained raw score. Only the magnitude of score can decide the degree of science motivation of students from no science motivation to a very high science motivation. The efficiency of the scale is that it uses very simple, unambiguous, declarative, to the point focused questions on the motivation to learn science in courses rather than a multitude of contexts, such as hobbies and the Flesch-Kincaid formula indicates readability at the sixth-grade level (Glynn et al., 2011). Also the beauty of SMQ II is that it does not distinguish among different science subjects, but focuses on a general motivation to learn science (Chumbley et al., 2015).

D) Reliabilities

The reliabilities (internal consistencies) of the scales , assessed by Cronbach's alphas, are as following in an order from highest to lowest: career motivation(0.92), intrinsic motivation(0.89), self-determination (0.88), self-efficacy (0.83), and grade motivation (0.81). The Cronbach's alpha of all 25 items was reported as 0.92 which a very good and reliable value.

E)Validity

The Science Motivation Questionnaire II is confirmed to have good content and criterion-related validity (Glynn, Taasoobshirazi & Brickman, 2009; Glynn, Brickman, Armstrong & Taasoobshirazi, 2011).

A sample of the Science Motivation Questionnaire (SMQ) II is attached vide **Appendix 4.**

Dimension wise splitting of the Science Motivation Questionnaire is explained in **Appendix 5.**

3.4.3 Science Anxiety Questionnaire (SAQ)

For the present investigation an adapted version of 'Science Anxiety Questionnaire' developed by Czerniak & Chiarelott (1984).The constructed questionnaire is an adaptation of the initial scale but was subjected to modification for making it suitable for the present sample. After taking the initial idea of the questionnaire some modifications were done to assess the level of science anxiety amongst the sample. The modification was performed to suit the indigenous requirement of the study with addition and deletion of some items as reported by Czerniak & Chiarelott (1984) in their study. The original scale had a list of 40 items on 4 dimensions which are Testing, Direct application of scientific principles, General application of scientific principles and Performance in front of others. It was tried to identify the possible dimensions for measurement of science anxiety taking initial idea from the initial study. The investigator decided to develop the questionnaire with six dimensions taking insights from the parent study of Czerniak & Chiarelott (1984); Yurkewicz (1988);Kaya& Yildirim (2014) and other studies in the field of Science anxiety instrument construction. Czerniak & Chiarelott (1984) originally kept

six dimensions for their science anxiety questionnaire after being subjected to factor analysis procedure and the initial six dimensions were later collapsed with the existing four dimensions on the basis of item similarity. Some items in original scale also related to classroom environment in context of teacher's behavior and home environment in context of parents' behavior. However, no dimension in relation to human relationship and interaction has been kept in the original questionnaire. Further researches confirm that there is definitely an important role of human interactions, be in classroom or at home that contributes to science anxiety.Yurkewicz (1988) identified teachers' behavior causing science anxiety and Kaya & Yildirim (2014) identified parents' attitude as an important predictor of science anxiety amongst their wards. In light of these studies it was decided to create two more dimensions related to these aspects contributing to science anxiety along with initial four dimensions. The final Science Anxiety Questionnaire (SAQ) comprised of thirty items with six dimensions. So the modification done were creation of 6 dimensions in place of 4 initial dimensions and the 40 initial items were reduced to 30 items with some addition and deletion of items. Each dimension had five items relating to the factor dimension of science anxiety. Owing to modifications of the new questionnaire over the original questionnaire, all the procedures of item analysis were performed for the modified questionnaire.

Process of scale construction

A) Selection of Statements: As mentioned above the selection of the statements for the questionnaire were done taking initial idea from the original study of Czerniak & Chiarelott (1984). Almost half of the items were retained from original questionnaire and many items were freshly framed. The reason of this modification was the original questionnaire was framed in context of American students and their science curriculum and hence many of the items were found incompatible in terms of contextual setting they depict. For e.g. one item in the original questionnaire mentions, '*lightening a grill for barbeque'* under the dimension of general application of science which was not fitting with the contextual setting of present sample. So the item was removed. New items were constructed using experts' opinion. Moreover, the original instrument requires updating in the light of curriculum changes over past three decades, hence the modification is justified. Although the original questionnaire was subjected to factor analysis, but no factor analysis was performed to derive the dimensions in the self-constructed questionnaire. However, experts' opinion suggested that the chosen dimensions are by and large capable of assessing science anxiety of secondary school students. Both the original and modified questionnaire are attached in the appendices for comparison. Following are the dimensions of the self-constructed Science Anxiety Questionnaire(SAQ)

*B) Dimensions of Science Anxiety***:** Studies indicate that science anxiety can be measured under certain dimensions (Czerniak & Chiarelott, 1984; Kaya & Yildirim, 2014, Kaya, 2013). The present Science anxiety questionnaire has the following 6 dimensions. The dimensions are created after reviewing a number of earlier studies and experts' opinion:

1. ***Fear of testing*:** This dimension deals with the level of fear within the students displayed against any kind of testing such as class tests, monthly or weekly tests, annual exams, quizzing, explaining experiments in science labs. It is analogous to 'Testing' factor dimension of original questionnaire.

2. ***Application of science*:** It assess the feeling of students while performing some process skills in science lab such as measuring, weighing, taking a reading, focusing lenses, and connecting wires etc. as a part of their science experiments. The statements under this dimension were prepared after carefully examining the laboratory manual prescribed under the MBSE curriculum for class X. It is analogous to 'Direct application of scientific principles' factor dimension of the original questionnaire.
3. ***Performance in front of others*:** It deals with the level of confidence within students, to handle lab equipments, demonstrating the concepts and mechanism on standalone platforms, working in front of masses etc. It is analogous to 'Performance in front of others' factor dimension of original questionnaire.
4. ***Teachers' behaviour, teaching style and teaching environment*:** It assesses students' feelings about their science teachers' behaviour, teaching styles and science classroom environment in terms of their favourability for learning science. This dimension was newly created keeping some items from the original questionnaire.
5. ***Content mastery*:** It covers students' level of anxiety in terms of their reactions while mastering and applying science content. It is analogous to 'General application of scientific principles' factor dimension of original questionnaire.
6. ***Parents' expectation:*** This dimension relates to the feelings of the students against the attitude and expectations of their parents towards their science achievement. This dimension was newly created keeping some items from the original questionnaire.

A sample of the Original Science Anxiety Questionnaire (SAQ) is attached vide **Appendix 6.**

Dimension wise splitting of the Adapted Science Anxiety Questionnaire is explained in **Appendix 7** and final form of Adapted Science Anxiety Questionnaire used for data collection is attached vide **Appendix 8.**

C) Scoring Procedure

The same scoring procedure was used as mentioned in Science Anxiety Questionnaire by Czerniak, & Chiarelott (1984).Five likert-type statements were framed under each dimension. Then they were arranged randomly. The objective was to assess the science anxiety levels under different dimensions. The respondents were expected to rate their response on a continuum ranging from "very relaxed", "relaxed", "neutral", "tensed" and "very tensed" by placing them in the frame of the feeling they experience as they read each statement. Each category was given a corresponding weight of 1, 2, 3, 4, & 5. It was assumed that greater degree of tension is perceived by those who are more science anxious and were given high score on science anxiety.

D)Try out of first draft

It was very important to try out the first draft of any instrument on a small sample of population. Hence the first draft of science anxiety questionnaire was administered on a sample of 50 students of class X. Students were given proper instruction before responding the questionnaire. The students could complete their responses in less than 15 minutes without any problem.

E)Item analysis

After the initial try out of the first draft of questionnaire its items were subjected to the procedure of item analysis. Item analysis is a technique through which those items which are valid and suited to the purpose are selected and the rest are either eliminated or modified to suit the purpose (Singh, 2008). Item discrimination index for each item was calculated by using t-test (Guilford, 1979). For this purpose the 30 items science anxiety questionnaire was administered on a group of 150 students of class X in some local schools. The obtained total scores based on

responses of students were then arranged in descending order and the upper and lower 27% of the total scores were separated out. These two formed the upper and lower science anxiety groups. Since the chosen sample size was 150, both upper and lower group comprised of 41 respondents. The‘t’ values were calculated for each item for the upper and lower groups. The‘t’ values along with the mean and standard deviation value for each item is listed in Table-3.7. The result of the analysis revealed that all the 30 items were found to discriminate between the upper and lower groups significantly. Except for item 3 & 27, all items were found significant at 0.01 level of significance with t value greater than t critical value of 2.64 for 80 degrees of freedom. Items 3 & 27 were found to be significant at 0.05 level of significance with t value greater than t critical value of 1.99 for 80 degrees of freedom. Hence all the items were retained for final draft of questionnaire.

TABLE 3.7

Item Discrimination Index for Science Anxiety Questionnaire

Item Number	Group	Mean	SD	Item Discrimination ‘t’ value	Significant - S Non-Significant-NS	Item Status Accepted - A Rejected – R
1.	Lower Group	2.51	1.03	5.09	S**	A
	Upper Group	3.61	0.92			
2.	Lower Group	3.24	1.04	3.43	S**	A
	Upper Group	4.00	0.95			
3.	Lower Group	2.68	1.13	2.27	S*	A
	Upper Group	3.24	1.11			
4.	Lower Group	2.88	1.07	4.78	S**	A
	Upper Group	4.00	1.04			
5.	Lower Group	3.32	1.25	5.71	S**	A
	Upper Group	4.59	0.67			
6.	Lower Group	2.51	1.14	7.37	S**	A
	Upper Group	4.09	0.77			
7.	Lower Group	1.88	0.95	5.55	S**	A
	Upper Group	3.15	1.10			
8.	Lower Group	2.59	1.25	5.09	S**	A
	Upper Group	3.95	1.18			
9.	Lower Group	2.39	0.95	4.43	S**	A
	Upper Group	3.44	1.18			
10.	Lower Group	2.71	1.03	5.28	S**	A
	Upper Group	3.80	0.84			
11.	Lower Group	2.29	1.31	4.94	S**	A
	Upper Group	3.59	1.05			
12.	Lower Group	2.71	1.06	7.01	S**	A
	Upper Group	4.12	0.75			
13.	Lower Group	2.32	1.33	3.85	S**	A

	Upper Group	3.34	1.06			
14.	Lower Group	2.76	1.09	6.19	S**	A
	Upper Group	4.12	0.89			
15.	Lower Group	2.37	1.04	4.25	S**	A
	Upper Group	3.29	0.93			
16.	Lower Group	2.68	0.85	4.47	S**	A
	Upper Group	3.63	1.07			
17.	Lower Group	2.61	1.07	5.82	S**	A
	Upper Group	3.85	0.85			
18.	Lower Group	2.81	0.78	4..21	S**	A
	Upper Group	3.59	0.89			
19.	Lower Group	2.66	1.28	5.57	S**	A
	Upper Group	4.00	0.87			
20.	Lower Group	2.88	1.32	5.75	S**	A
	Upper Group	4.37	0.99			
21.	Lower Group	3.22	1.08	4.94	S**	A
	Upper Group	4.29	0.87			
22.	Lower Group	2.88	1.21	7.34	S**	A
	Upper Group	4.46	0.67			
23.	Lower Group	2.27	0.87	4.40	S**	A
	Upper Group	3.07	0.79			
24.	Lower Group	2.61	0.97	4.13	S**	A
	Upper Group	3.46	0.89			
25.	Lower Group	2.98	0.88	3.55	S**	A
	Upper Group	3.63	0.79			
26.	Lower Group	2.56	1.09	7.03	S**	A
	Upper Group	4.17	0.97			
27.	Lower Group	2.56	0.95	2.50	S*	A
	Upper Group	3.12	1.08			
28.	Lower Group	2.54	0.84	7.09	S**	A
	Upper Group	3.93	0.93			
29.	Lower Group	2.68	1.13	6.71	S**	A
	Upper Group	4.19	0.90			
30.	Lower Group	2.27	1.16	6.38	S**	A
	Upper Group	3.93	1.19			

** significant at 0.05 level, ** significant at 0.01 level*

F) Validity Testing

Since, percentage of modification were more than 50%, the questionnaire was subjected to content and concurrent validity testing followed by reliability testing. Five experts from the field of science were consulted for the content and face validity of the items. The items were found to be highly reliable by them. The concurrent criterion validity of questionnaire used in the present study was found to be 0.68 with previous study (Czerniak, & Chiarelott, 1984) which was acceptable. However, no factor analysis has been performed for the choice of the dimensions of the scale, but the item contents for each of the six dimensions was analyzed through expert views and the items were found highly valid by them.

The experts' responses on Google Forms are attachedvide **Appendix-11**

Construct Validity

An inter correlation between the scores on each of the six dimension (DIM 1-6) and with the total score was calculated for the total sample population. Table 3.8 shows the correlation values. All correlations were found to be positive and significant at 0.01 level of significance. Table 3.8 presents the inter correlation values between the six dimensions.

Table 3.8

Inter-Correlation between the Dimensions of Science Anxiety

	DIM 1	**DIM 2**	**DIM 3**	**DIM 4**	**DIM 5**	**DIM6**	**TOTAL**
DIM 1	1.00						
DIM2	0.33	1.00					
DIM 3	0.62	0.40	1.00				
DIM 4	0.42	0.40	0.48	1.00			
DIM 5	0.55	0.43	0.55	0.55	1.00		
DIM 6	0.48	0.27	0.42	0.41	0.46	1.00	
TOTAL	0.78	0.62	0.79	0.73	0.79	0.70	1.00

All correlations shown above are significant at level 0.01.(N=1134)

G)Reliability Testing

The reliability of the questionnaire with test-retest method was found 0.87 with an approximate one month's gap. The cronbach alpha coefficient for internal consistency on test and retest were found 0.86 and 0.84 respectively. A split half test was also performed on all the 30 items with first 15 items in first half and last 15 items in second half of test. The reliability value was found 0.865 after applying Spearman-Brown prophecy formula which was very much equivalent to high reliability.

3.4.4 Emotional Stability Scale (ESS)

Although some standardized questionnaires and scales were available, it was decided by the investigator to construct a scale on own which could be easily answered by the secondary school students with the possibility of using simplified statements for items. The choice of construction of the scale is justified because the available scales were either very lengthy to be administered and some of the scales were not compatible to the present sample.

Process of scale construction

A) Selection of Statements

For the purpose of selection of statements some standardized questionnaires and scales were consulted and relevant literature review was done. Emotional stability is one of the sub factors of big five factors for personality assessment in the Five-factor Personality Inventory (FFPI), 1998.

FFPI was consulted along with Emotional Stability Questionnaire (ESQ) by PSY-COM Services, 1995 for the preparation of first draft of scale. In the initial attempt a total of 50 items were framed. These items were shown to the experts from the field educational psychology for their suitability in measuring the construct of emotional stability. After consulting the experts nearly 20 items were discarded and only 30 items were retained for the first draft of the scale. However no dimensions were identified for this scale. The scoring procedure was also finalized for the scale with the help of experts view.

B) Scoring Procedure

Three (3) Point Likert Scale was used for the gathering the responses of the students. The emotional stability scale tried to measure the student's feeling and emotional response upon reading various situational statements through the preferential choice of any of the three provided options which were 'Often', 'Sometimes' or 'Rarely'. Since there were both positive and negative statements in the scale the corresponding weighted score for positive statements will be 3, 2, 1 respectively for 'often', 'sometimes' or 'rarely' and for negative statements will be 1, 2,3 respectively for 'often', 'sometimes' or 'rarely'. All together the maximum possible score was 90 (3 x 30) and least possible score was 30 (1 x 30).

C)Scoring Key

Table 3.9
Scoring Key for the Emotional Stability Scale

Sl. No.	Types of Items	Serial No. of Items
1.	Positive Items (19)	1, 5, 6, 7, 10, 11, 12, 13, 15, 16, 17, 18, 20, 21, 22, 23, 24, 27, 30
2.	Negative Items (11)	2, 3, 4, 8, 9, 14, 19, 25, 26, 28, 29

Clear cut instructions were framed for students which guided them with the procedure of providing their responses.

D) Try out of first draft

It was very important at the initial stage to try out the first draft of any instrument on a small sample of population to identify any form of ambiguities in it. Hence the first draft of emotional stability scale was administered on a sample of 50 students of class X. Students were given proper instruction before responding the scale. The students could complete their responses in less than 15 minutes without any problem. The main purpose of this initial try out was achieved and it was found that students were able to easily understand the instructions provided in the scale and appropriately provide their responses. It was interesting to note that students could easily relate the situational context of each item with their own life experiences. Also they found the language of the item statements easy to comprehend.

E) *Item analysis*

After the initial try out of the first draft of scale its items were subjected to the procedure of item analysis. Item analysis is a technique through which those items which are valid and suited to the purpose are selected and the rest are either eliminated or modified to suit the purpose (Singh, 2008.). Item discrimination index for each item was calculated by using t-test (Guilford, 1979).

For this purpose the 30 items emotional stability scale was administered on a group of 150 students of class X in some local schools. The obtained total scores based on responses of students were then arranged in descending order and the upper and lower 27% of the total scores were separated out. These two formed the upper and lower emotional stability groups. Since the chosen sample size was 150, both upper and lower group comprised of 41 respondents. The 't' values were calculated for each item for the upper and lower groups. The 't' values along with the mean and standard deviation value for each item is listed in Table-3.10. The result of the analysis revealed that items 3, 17 and 28 were found to be insignificant in discrimination power at 0.05 level of significance as the obtained 't' value was less than t critical value of 1.99 for 80 degrees of freedom. Rest all 27 items were found to discriminate between the upper and lower groups significantly at 0.05 level of significance. Hence items 3, 17 and 28 were found unsuitable and discarded from the draft scale.A sample of the First Draft of Emotional Stability Scale (ESS) is attached vide **Appendix-9** and the final form of the Emotional Stability Scale (ESS) used for data collection is attached vide **Appendix-10**

TABLE 3.10

Item Discrimination Index for Emotional Stability Scale

Item Number	Group	Mean	SD	Item Discrimination 't' value	Significant - S Non-Significant- NS	Item Status Accepted - A Rejected – R
1.	Lower Group	1.66	0.53	4.28	S**	A
	Upper Group	2.27	0.74			
2.	Lower Group	1.93	0.82	2.11	S*	A
	Upper Group	2.29	0.75			
3.	Lower Group	1.85	0.76	0.14	NS	R
	Upper Group	1.83	0.86			
4.	Lower Group	1.83	0.70	3.57	S**	A
	Upper Group	2.32	0.52			
5.	Lower Group	2.15	0.65	2.59	S*	A
	Upper Group	2.54	0.71			
6.	Lower Group	2.24	0.73	2.04	S*	A
	Upper Group	2.56	0.67			
7.	Lower Group	1.98	0.65	4.63	S**	A
	Upper Group	2.61	0.59			
8.	Lower Group	2.00	0.63	2.64	S**	A
	Upper Group	2.37	0.62			
9.	Lower Group	1.83	0.67	4.21	S**	A
	Upper Group	2.41	0.59			
10.	Lower Group	2.02	0.65	2.51	S*	A
	Upper Group	2.39	0.67			
11.	Lower Group	1.98	0.61	2.85	S**	A

	Upper Group	2.39	0.70			
12.	Lower Group	1.95	0.74	3.28	S**	A
	Upper Group	2.46	0.67			
13.	Lower Group	1.90	0.70	4.07	S**	A
	Upper Group	2.48	0.59			
14.	Lower Group	1.68	0.61	2.39	S*	A
	Upper Group	2.00	0.59			
15.	Lower Group	1.88	0.68	5.11	S**	A
	Upper Group	2.63	0.66			
16.	Lower Group	1.71	0.64	5.36	S**	A
	Upper Group	2.49	0.68			
17.	Lower Group	1.63	0.83	1.41	NS	R
	Upper Group	1.90	0.89			
18.	Lower Group	2.09	0.58	2.54	S*	A
	Upper Group	2.44	0.63			
19.	Lower Group	1.90	0.74	5.75	S**	A
	Upper Group	2.71	0.51			
20.	Lower Group	1.98	0.61	4.21	S**	A
	Upper Group	2.54	0.59			
21.	Lower Group	1.78	0.68	5.88	S**	A
	Upper Group	2.63	0.62			
22.	Lower Group	1.71	0.72	4.65	S**	A
	Upper Group	2.44	0.71			
23.	Lower Group	2.09	0.77	2.25	S*	A
	Upper Group	2.44	0.59			
24.	Lower Group	2.05	0.74	3.44	S**	A
	Upper Group	2.60	0.74			
25.	Lower Group	1.83	0.63	2.24	S*	A
	Upper Group	2.15	0.65			
26.	Lower Group	2.09	0.74	2.73	S**	A
	Upper Group	2.51	0.64			
27.	Lower Group	1.93	0.75	3.35	S**	A
	Upper Group	2.41	0.55			
28.	Lower Group	1.73	0.74	1.85	NS	R
	Upper Group	2.02	0.69			
29.	Lower Group	1.73	0.74	3.46	S**	A
	Upper Group	2.31	0.79			
30.	Lower Group	1.98	0.72	5.99	S**	A
	Upper Group	2.8	0.51			

** significant at 0.05 level, ** significant at 0.01 level*

F) *Final Draft*

After item analysis, all those items were retained which were able to discriminate between lower and upper groups at 0.05 level of significance. The final draft therefore could retain 27 items out of which items 1, 4, 7, 8, 9, 11, 12, 13, 15, 16, 19, 20, 21, 22, 24, 26, 27, 29, 30 were found significant at 0.01 level of significance and items 2, 5, 6, 10, 14, 18, 23, 25 were found significant at 0.05 level of significance.

G)Reliability Testing

It was important to assess the reliability of the constructed instrument in order to ascertain the trustworthiness of the results obtained through it. Hence, the final draft of the emotional stability scale was subjected to reliability testing. For finding the reliability of the scale, initially split-half method was employed. The 27 items in the scale were divided into first and second half with first half comprising of 14 items and second half comprising of 13 items. The reliability is calculated by applying product moment correlation between the two forms. It was obtained as 0.561 after applying Spearman-Brown formula which was moderately acceptable. The split half reliability in-between odd-even items was 0.701, with 14 odd items and 13 even items after applying Spearman-Brown formula which is an acceptable value for reliability. Test-retest method was also employed to have further assessment of reliability. The gap kept between the test and retest was kept approximately a month. The test-retest reliability was found to be 0.68. The Cronbach Alpha coefficient for internal consistency on test and retest were found 0.562 and 0.432 respectively. This was also moderately acceptable reliability.

H)Validity testing

As already mentioned the items selected for the present scale were in consultation with experts from educational psychology. In order to establish the content validity of the final draft scale opinion was sought from eight experts from the field of psychology. The items were found to be valid for the chosen purpose of the scale and easy to comprehend. The experts' responses on Google Forms are attached vide **Appendix-12**

3.4.5 Unstructured interview

Technique of unstructured interview was used to draw some relevant data on schools' situational setting. The interviews were conducted by the researcher in a very informal way with science teachers, school principals subject to their availability for gaining further insights into the research questions. Besides this occasional informal discussions were done primarily with the sampled students during the school visits.

3.5 Data Collection Procedure

The data was collected in three distinct phases which were

Phase I

In this phase investigator administered the scientific temper scale, science motivation questionnaire, science anxiety questionnaire and emotional stability scale on the chosen sample of Class X secondary school students of Aizawl district of Mizoram in the block year 2016-17 between the months of June-Dec. The available students of Class X were given

questionnaire/scale and asked to fill in their choices against the given items after explaining them the process of answering. Beside this the researcher also conducted unstructured interviews with some teachers, principals and selected students during the field visits to facilitate her investigation. In this phase all the data collected was of primary nature.

Phase II

In the second phase data related to class X state board result (HSLC result) was collected from MBSE office when the board results were declared in May, 2017. The obtained data was of secondary nature

3.6 Scoring and Tabulation of Data

After the collection of both primary and secondary data, the total obtained data was scored and tabulation was done. The tabulated data was subjected to data cleaning using statistical package. High and low achievers in science were identified on the basis of the criterion of the upper and lower 27% of science achievement scores as explained earlier in this chapter.

3.7 Statistical Techniques Employed in the Research

Keeping in view objectives of the study and nature of variables following statistics has been used:

i) Descriptive analysis has been used to understand the nature of distribution of various variables of study in terms of measures of central tendency (Mean, Median, Mode), measures of dispersion(Range, Standard deviation) and measures of shape(Skewness and Kurtosis) and Percentages.

iii) To understand the differences in affective variables with respect to science achievement and gender the independent t-test was used.

iv)To understand the association between gender and affective variables 'χ^2'test of independence was used.

v) To understand the correlation between affective variables (independent) and science achievement (dependent) both Pearson's Product moment correlation and Spearman's Rank order correlational analysis has been used. Further partial correlation of 1^{st}, 2^{nd} and 3^{rd} order and multiple correlation statistics has been used to understand the net and collective relationship between the independent and dependent variables. Similarly to understand the correlation between affective variables and overall academic achievement Pearson's Product moment correlation has been used and partial correlation of 1^{st}, 2^{nd} and 3^{rd} order and multiple correlation statistics has been used to understand the net and collective relationship.

CHAPTER-4
ANALYSIS AND INTERPRETATION OF DATA

ANALYSIS AND INTERPRETATION OF DATA

4.0 Introduction

Research aims at discovering patterns of reality to progress towards the real truth and much of this task is done through proper tabulation, analysis and interpretation of the collected data. This stage of research is directed through research hypotheses and to test the assumed hypotheses, *null hypotheses* are framed and tested.

After administering, scoring and tabulating the various scales of the study and students' scores in science, raw data was obtained which was subjected to data analysis using appropriate statistical methods and techniques. This was followed by quantitative and qualitative interpretations of analysis to draw meaningful findings and conclusions.

This chapter is developed into five sections on the basis of different types of analysis used for various objectives which are as follows:

1. Descriptive Analysis
2. Differential Analysis
3. Correlational Analysis
4. Situational Analysis
5. Logical Analysis

4.1 Descriptive Analysis

At a very foremost stage of research analysis a proper description of data is must, which gives a clear picture of distribution of variables of study in the sample population. Hence, the obtained raw data was analyzed in terms of its distribution pattern in the population of investigation as already explained in last chapter. This section of the study deals with objectives related to description of secondary school students on the affective variables of scientific temper, science motivation, science anxiety, and emotional stability; and their achievement in science and overall achievement (Objectives 1 & 2). The description is in terms of measures of central tendencies, measures of dispersions and measures of shapes-kurtosis and skewness.

Table 4.1 gives the description on the nature of the data collected from the sample.

Table 4.1

Distribution of Achievement Score in Science& Overall Academic Achievement (Dependent Variables) and Scientific Temper, Science Motivation, Science Anxiety & Emotional Stability (Independent Variables) in Terms of Mean, Median, Mode, Range, Standard Deviation, Kurtosis And Skewness Values

Variable Name (N=1134)	Mean	Median	Mode	SEM	Range	SD	Skewness	Kurtosis	SES (Standard Error of Skewness)	SEK(Standard Error of Kurtosis)
Scientific Temper(0-50)	33.00	34	35	0.188	34	6.32	-.442	-.251	.073	.145
Science Motivation(0-100)	66.85	68	71	0.433	88	14.58	-.450	.098	.073	.145
Science Anxiety(30-150)	96.39	98	99	0.457	110	15.40	-.664	.948	.073	.145
Emotional Stability(30-81)	57.60	57	56	0.152	35	5.13	.237	-.030	.073	.145
Science achievement in Board Exams(100)	57.04	56	47	0.447	75	15.05	.110	-.481	.073	.145
Overall achievement in Board Exams(500)	301.70	305	300	2.11	365	71.21	-.232	-.539	.073	.145

Source: Field data

Description of Table 4.1: The table gives the description onthe distribution of scores of students for the four independent variables studied namely, Scientific Temper (ST), Science Motivation (SM), Science Anxiety (SA) and Emotional Stability (ES) and the main dependent variable Science Achievement (Sc. Ach.). A description of students' overall achievement in board exams are also depicted in Table 4.1. The Table depicts the Mean, Median and Mode values of various variables as a Measures of Central Tendency with Standard Error of Mean (SEM). The table depicts the measures of Dispersions of Range and Standard deviation (SD) as a Measures of Variance. Also as the measure of shape of the distribution, the Kurtosis and Skewness values along with their standard errors (SES, SEK) are shown.

Following assumptions on the shape of distribution has been kept in mind for interpreting the Skewness and Kurtosis values.

Skewness assesses the extent to which a variable's distribution is symmetrical (Hair et al., 2017, p. 61). Distributions are said to be skewed negatively or to the left when scores are massed at the high end of the scale (the right end).Distributions are said to be skewed positively or to the right when scores are massed at the low end of the scale (the left end).

Kurtosis has to do with the extent to which a frequency distribution is peaked or flat (Hair et al., 2017, p. 61).The negative value of kurtosis means that there is limited data towards the tails and more data is in middle of the distribution i.e. it is platykurtic,- a "negative" or flat and wide-spread distribution with thin tails.The positive value of kurtosis i.e. a leptokurtic distribution means that there is more data towards the tails and less data is in middle of the distribution i.e. it is leptokurtic, - a "positive" or tall-narrow and thin distribution with fatter tails.

4.1.1 Level and Nature of Distribution of Selected Affective Variables (ST, SM, SA, ES) Among Secondary School Students

*Interpretation of Scientific Temper (ST) scores:*The range of score possible on the scientific temper scale used by the researcher is 0-50. However, the range of score obtained by the sample students was found from 13 to 47 with a mean of 33, median of 34 and mode of 35. The distribution has a range of 34, SD of 6.32 and SEM of 0.188. The skewness value is -.442 (SES=.073) and the kurtosis value is -.251 (SEK=.145). Skewness and Kurtosis values within the range of +/- 2.(SE) are generally considered normal. Here the given value of skewness is not within the range of -.146 to +.146 which means the distribution is found to be negatively skewed. Another general guideline for skewness is that if the number is greater than +1 or lower than –1, this is an indication of a substantially skewed distribution (Hair et al., 2017, p. 61). Applying this guideline the skewness value(-.442)qualifies to be within the limits of normality. Kurtosis value is within the range of -0.29 to +0.29, which is considered normal. For kurtosis, the general guideline is that if the number is greater than +1, the distribution is too peaked. Likewise, a kurtosis of less than –1 indicates a distribution that is too flat (Hair et al., 2017, p. 61). Applying this guideline the kurtosis value (-.251) qualifies to be within the limits of normality. The

histogram with normal curve overlay is depicted in Fig.4.1. Considering the skewness and kurtosis statistics, the data description indicate that the scientific temper (ST) scores of secondary school students are reasonably normally distributed. There is slight negative skew such that there are more scores at the high end of the distribution than a typical normal distribution. This reveals that the level of ST is towards the higher side in the sample population which is desirable. There is also a slight negative kurtosis indicating this distribution is slightly flatter than a normal distribution. It means the distribution is slightly platykurtic. Again, however the values are within the range of what is considered a reasonable approximation to the normal curve.

*Interpretation of Science Motivation (SM) scores:*The range of score possible on science motivation questionnaire as used by the researcher is 0-100. The least obtained score was that of 12 and maximum obtained score was that of 100. The mean value of the scores obtained from the sample population is 66.85 with SEM of 0.433. The median and mode value are 68 and 71. The range and SD value are 88 and 14.58 respectively. The skewness value is -.450 (SES=.073) and the kurtosis value is .098 (SEK=.145). Skewness and Kurtosis values within the range of +/- 2.(SE) are generally considered normal. Here the given value of skewness is not within the range of -.146 to +.146 which means the distribution is found to be negatively skewed. Another general guideline for skewness is that if the number is greater than +1 or lower than –1, this is an indication of a substantially skewed distribution (Hair et al., 2017, p. 61). Applying this guideline the skewness value(-.450)qualifies to be within the limits of normality. Kurtosis value is within the range of -0.29 to +0.29, which is considered very normal. For kurtosis, the general guideline is that if the number is greater than +1, the distribution is too peaked. Likewise, a kurtosis of less than –1 indicates a distribution that is too flat (Hair et al., 2017, p. 61). Applying this guideline the kurtosis value (.098) qualifies to be within the limits of normality. The histogram with normal curve overlay is depicted in Fig.4.2. Considering the skewness and kurtosis statistics, the data description indicate that the science motivation (SM) scores of secondary school students are reasonably normally distributed. There is slight negative skew such that there are more scores at the high end of the distribution than a typical normal distribution. This reveals that the level of SM is towards the higher side in the sample population which is desirable. There is also a slight positive kurtosis indicating this distribution is slightly narrower than a normal distribution. It means the distribution is slightly leptokurtic. Again, however the values are within the range of what is considered a reasonable approximation to the normal curve.

*Interpretation of Science Anxiety (SA) scores:*The range of score possible on the science anxiety questionnaire used by the researcher is 30-150. However, the range of score obtained by the sample students was found from 30 to 140. The mean value of the scores obtained from the sample population is 96.39 with SEM of 0.457 and the median and mode are found to be 98 and 99 respectively. The distribution range and SD value are 110 and 15.40 respectively. The skewness value is -.664 (SES=.073) and the kurtosis value is .948 (SEK=.145). Skewness and Kurtosis values within the range of +/- 2.(SE) are generally considered normal. Here the given

value of skewness is not within the range of -.146 to +.146 which means the distribution is found to be negatively skewed. Another general guideline for skewness is that if the number is greater than +1 or lower than –1, this is an indication of a substantially skewed distribution (Hair et al., 2017, p. 61). Applying this guideline the skewness value(-.664)qualifies to be within the limits of normality. Kurtosis value is not within the range of -0.29 to +0.29, which is considered not normal. For kurtosis, another general guideline is that if the number is greater than +1, the distribution is too peaked. Likewise, a kurtosis of less than –1 indicates a distribution that is too flat (Hair et al., 2017, p. 61). Applying this guideline the kurtosis value (.948) qualifies to be within the limits of normality. The histogram with normal curve overlay is depicted in Fig.4.3. Considering the skewness and kurtosis statistics, the data description indicate that the science anxiety (SA) scores of secondary school students are not normally distributed. There is slight negative skew such that there are more scores at the high end of the distribution than a typical normal distribution. This suggests that the level of SA is towards the higher side in the sample population which is undesirable. The positive value of kurtosis (.948) means that there is more data towards the tails and less data is in middle indicating this distribution is slightly narrower than a normal distribution which means the distribution is slightly leptokurtic. Again, however the values are within the range of what is considered a reasonable approximation to the normal curve.

*Interpretation of Emotional Stability (ES) scores:*The range of score possible on the emotional stability scale used by the researcher is 30-81 with least obtained score of 41 and maximum obtained score of 76. The mean value of the scores obtained from the sample population is 57.60 with SEM of 0.152. The median value is 57 and the mode is 56. The range and SD value are 35 and 5.13 respectively. The skewness value is .237 (SES=.073) and the kurtosis value is -.030 (SEK=.145). Skewness and Kurtosis values within the range of +/- 2.(SE) are generally considered normal. Here the given value of skewness is not within the range of -.146 to +.146 which means the distribution is found to be slight positively skewed. Another general guideline for skewness is that if the number is greater than +1 or lower than –1, this is an indication of a substantially skewed distribution (Hair et al., 2017, p. 61). Applying this guideline the skewness value (.237) qualifies to be within the limits of normality. Kurtosis value is within the range of -0.29 to +0.29, which is considered very normal. For kurtosis, the general guideline is that if the number is greater than +1, the distribution is too peaked. Likewise, a kurtosis of less than –1 indicates a distribution that is too flat (Hair et al., 2017, p. 61). Applying this guideline the kurtosis value (-.030) qualifies to be within the limits of normality. The histogram with normal curve overlay is depicted in Fig.4.4. Considering the skewness and kurtosis statistics, the data description indicate that the emotional stability (ES) scores of secondary school students are reasonably normally distributed. There is very slight positive skew such that there are slightly more scores at the lower end of the distribution than a typical normal distribution. This reveals that the level of ES is more or less moderate in the sample population which is not a bad sign. There is a negligible amount of negative kurtosis indicating this distribution is near normal

identical to bell shape of normal curve. However the values are within the range of what is considered a reasonable approximation to the normal curve.

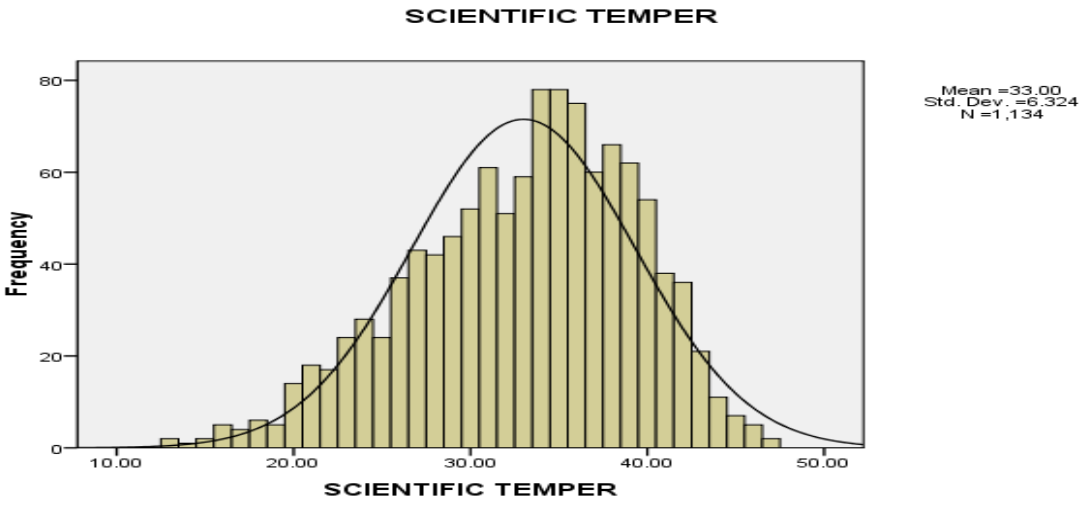

Fig. 4.1: Normal Plot for Students' Scores on Scientific Temper

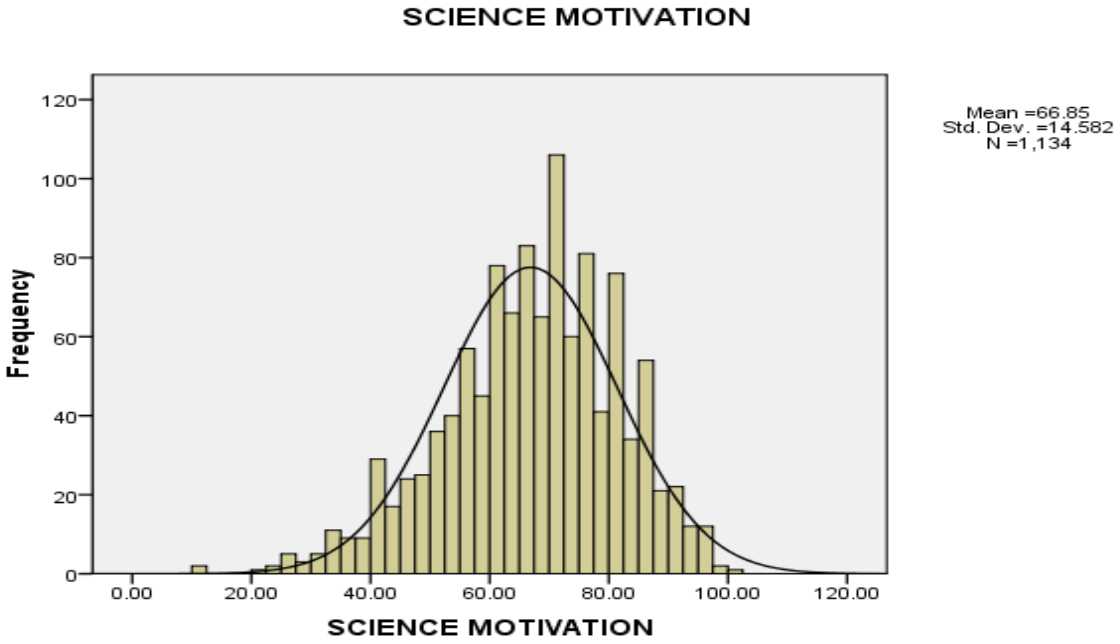

Fig. 4.2: Normal Plot for Students' Scores on Science Motivation

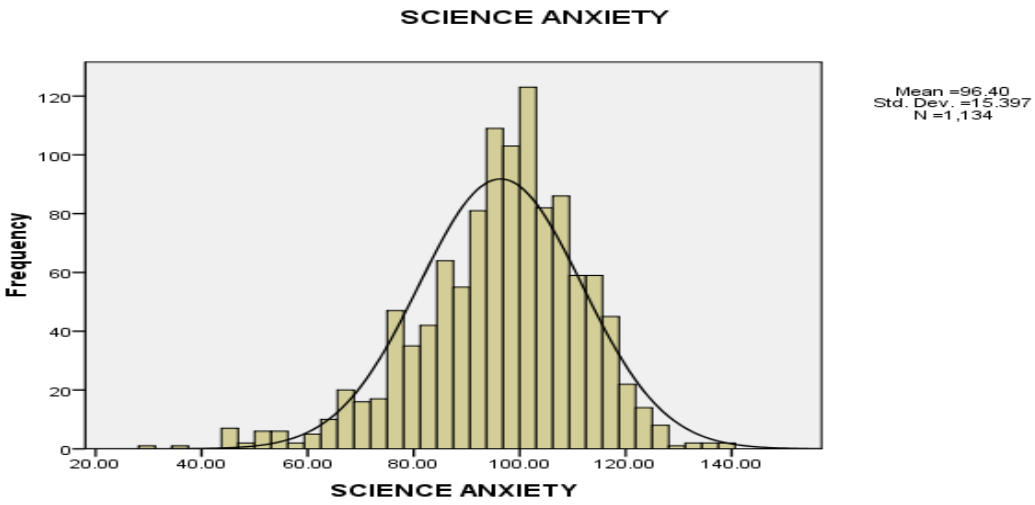

Fig. 4.3: Normal Plot for Students' Scores on Science Anxiety

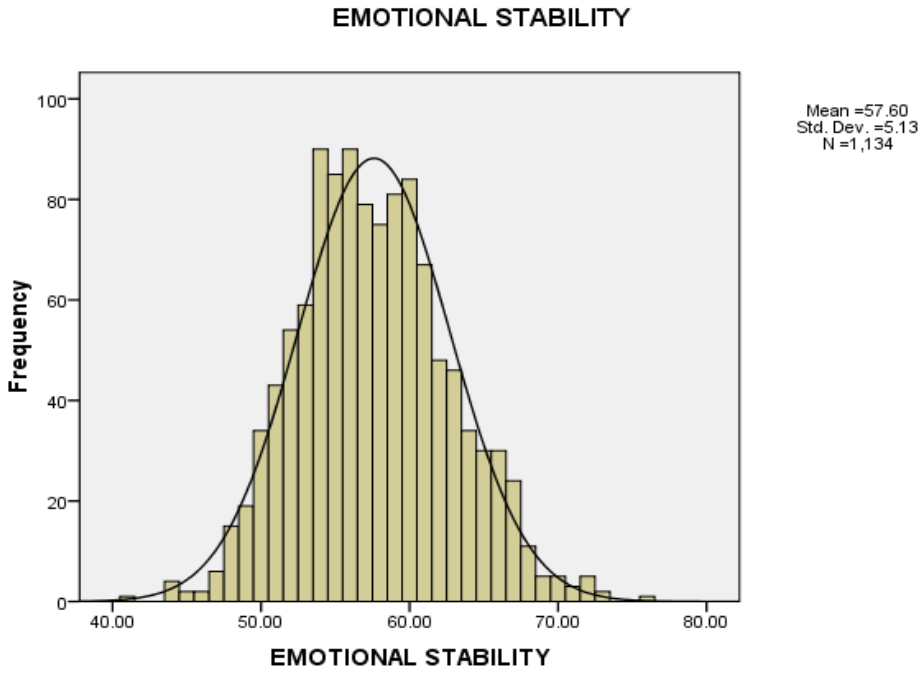

Fig. 4.4: Normal Plot for Students' Scores on Emotional Stability

4.1.2 Level and Nature of Distribution of Science and Overall Academic Achievement Among Secondary School Students

*Interpretation of Science Achievement (Sc. Ac.) scores:*The possible science achievement score range is 0-100 (MBSE board) with least obtained score of 21 and maximum obtained score of 96.The mean value of the scores obtained from the sample population is 57.04 with SEM of 0.447. The median and mode value are 56 and 47 respectively. The range and SD value are75 and 15.05 respectively. The skewness value is .110 (SES=.073) and the kurtosis value is -.481 (SEK=.145). Skewness and Kurtosis values within the range of +/- 2.(SE) are generally considered normal. Here the given value of skewness is well within the range of -.146 to +.146 which means the distribution is found to be normal. Another general guideline for skewness is that if the number is greater than +1 or lower than –1, this is an indication of a substantially skewed distribution (Hair et al., 2017, p. 61). Applying this guideline the skewness value(.110)qualifies to be within the limits of normality. Kurtosis value is not lying within the range of -0.29 to +0.29, which is considered not normal. For kurtosis, the general guideline is that if the number is greater than +1, the distribution is too peaked. Likewise, a kurtosis of less than –1 indicates a distribution that is too flat (Hair et al., 2017, p. 61). Applying this guideline the kurtosis value (-.481) qualifies to be within the limits of normality. The histogram with normal curve overlay is depicted in Fig.4.5. Considering the skewness and kurtosis statistics, the data description indicate that the science achievement (Sc. Ach.) scores of secondary school students are reasonably normally distributed. There is slight positive skew such that there are more scores at the lower end of the distribution than a typical normal distribution. This suggests that the level of science achievement is moderately uniform with slightly more distribution of scores below the mean value which is acceptable for a population. There is also a slight negative kurtosis indicating this distribution is slightly flatter than a normal distribution. It means the distribution is slightly platykurtic. Again, however the values are within the range of what is considered a reasonable approximation to the normal curve.

Interpretation of Overall Achievement in Class X (out of 500): The overall achievement score range is 0-500 with least obtained score of 101 and maximum obtained score of 466. The mean, median and mode value of the scores obtained by the sample population are 301.70, 305 and 300 respectively with SEM of 2.11. The range and SD value are 365 and 71.21 respectively. The skewness value is -.232 (SES=.073) and the kurtosis value is -.539 (SEK=.145). Skewness and Kurtosis values within the range of +/- 2.(SE) are generally considered normal. Here the given value of skewness is not within the range of -.146 to +.146 which means the distribution is found to be negatively skewed. Another general guideline for skewness is that if the number is greater than +1 or lower than –1, this is an indication of a substantially skewed distribution (Hair et al., 2017, p. 61). Applying this guideline the skewness value(-.232)qualifies to be within the limits of normality. Kurtosis value is also not within the range of -0.29 to +0.29, which is considered non-normal. For kurtosis, the general guideline is that if the number is greater than +1, the distribution is too peaked. Likewise, a kurtosis of less than –1 indicates a distribution that is too flat (Hair et al., 2017, p. 61). Applying this guideline the kurtosis value (-.539) qualifies to be

within the limits of normality. The histogram with normal curve overlay is depicted in Fig.4.6. Considering the skewness and kurtosis statistics, the data description indicates that the overall achievement (Acd. Ach.)scores of secondary school students are reasonably normally distributed. There is very slight negative skew such that there are more scores at the high end of the distribution than a typical normal distribution. This reveals that the level of overall achievement is towards the higher side in the sample population which is desirable. There is also a slight negative kurtosis indicating this distribution is slightly flatter than a normal distribution. It means the distribution is slightly platykurtic. Again, however the values are within the range of what is considered a reasonable approximation to the normal curve
Fig.4.7 gives a comparative graphical representation of frequency distribution of all the independent variables and the dependent variable.

It is assumed that we should first graphically see the data for normal distribution thorough visual inspection of the shape of the variable's distribution using histograms or frequency distribution graphs. Further it has been reported that no data is absolutely normal. It is always near normal.
Here it is important to mention Norton's study as reported by Kennedy &Bush (1985), "Summarizing the first phase of Norton's study Lindquist asserts: "Unless the departure from normality is so extreme that it can be easily detected by mere inspection of data, the departure from normality will probably have no appreciable effect on the validity of the F test and the probabilities read from the F table may be used as close approximations to the true probabilities" (1953, p.86)."
Further the authors concluded, "Based on the Norton study and similar studies which have followed , it is reasonable to conclude that departure from population normality have little effect, in practice, relative to spuriously inflating the probability of committing Type I errors. It has even been shown that this conclusion holds when sample n's are not equal. Thus the analysis of variance appears to be extremely robust with respect to violations of normality assumption, a finding that is more gratifying to behavioral researchers who sometimes find that population non-normality is the rule rather than the exception."

Thus Norton and other studies provide the evidence to use more powerful statistical techniques. Hence, parametric statistical procedure was applied to test the null hypothesis as the total score obtained on the sample population followed nearly a normal distribution with mean, median and mode for ST as 33, 34, 35; for SM as 66.85, 68, 71; for SA as 96.39, 98, 99; for ES as 57.60, 56, 47 and for Sc. Ach. 57.04, 56, 47 respectively.

Generally by the rule of thumb kurtosis value between -2 to +2 is considered near normal and similarly skewness value between -2 to +2 is considered near normal. If we inspect all the obtained values of kurtosis and skewness they are well within the range of -1 to +1, thus indicating obtained data is near normal.

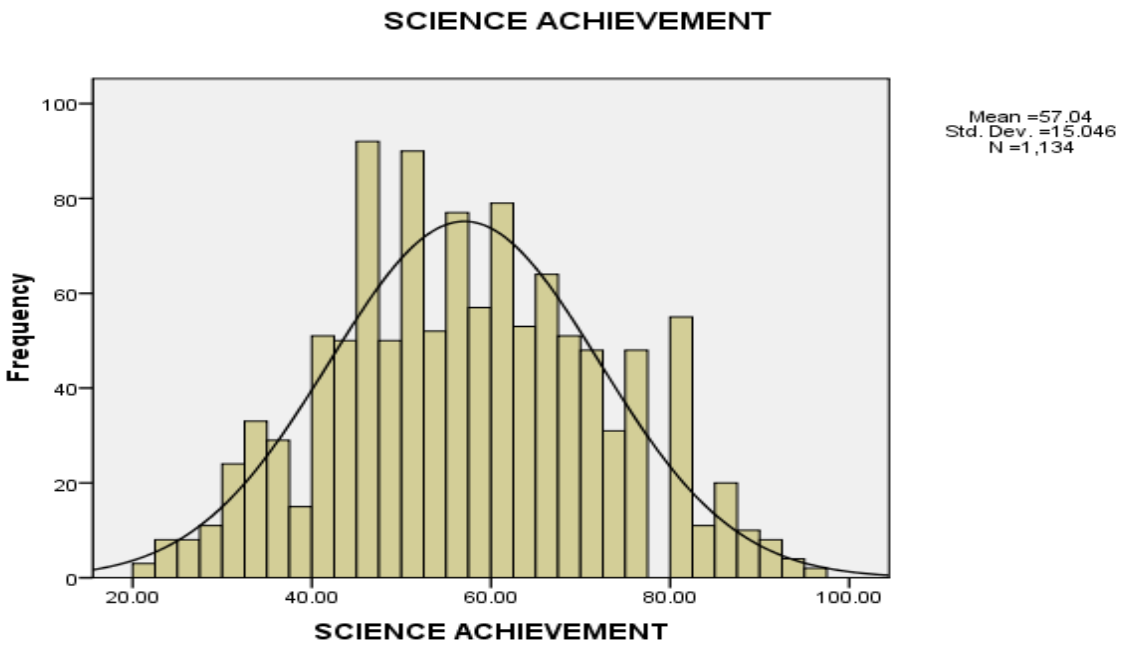

Fig. 4.5: Normal Plot for Students' Scores on Science Achievement

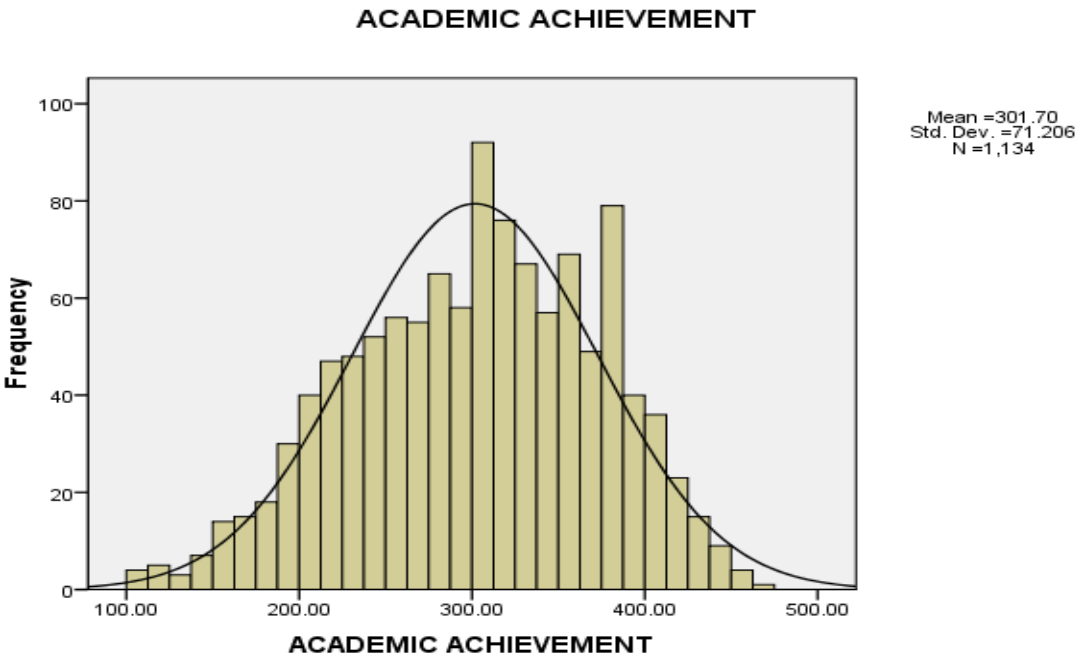

Fig.4.6: Normal Plot for Students' Scores on Overall Academic Achievement

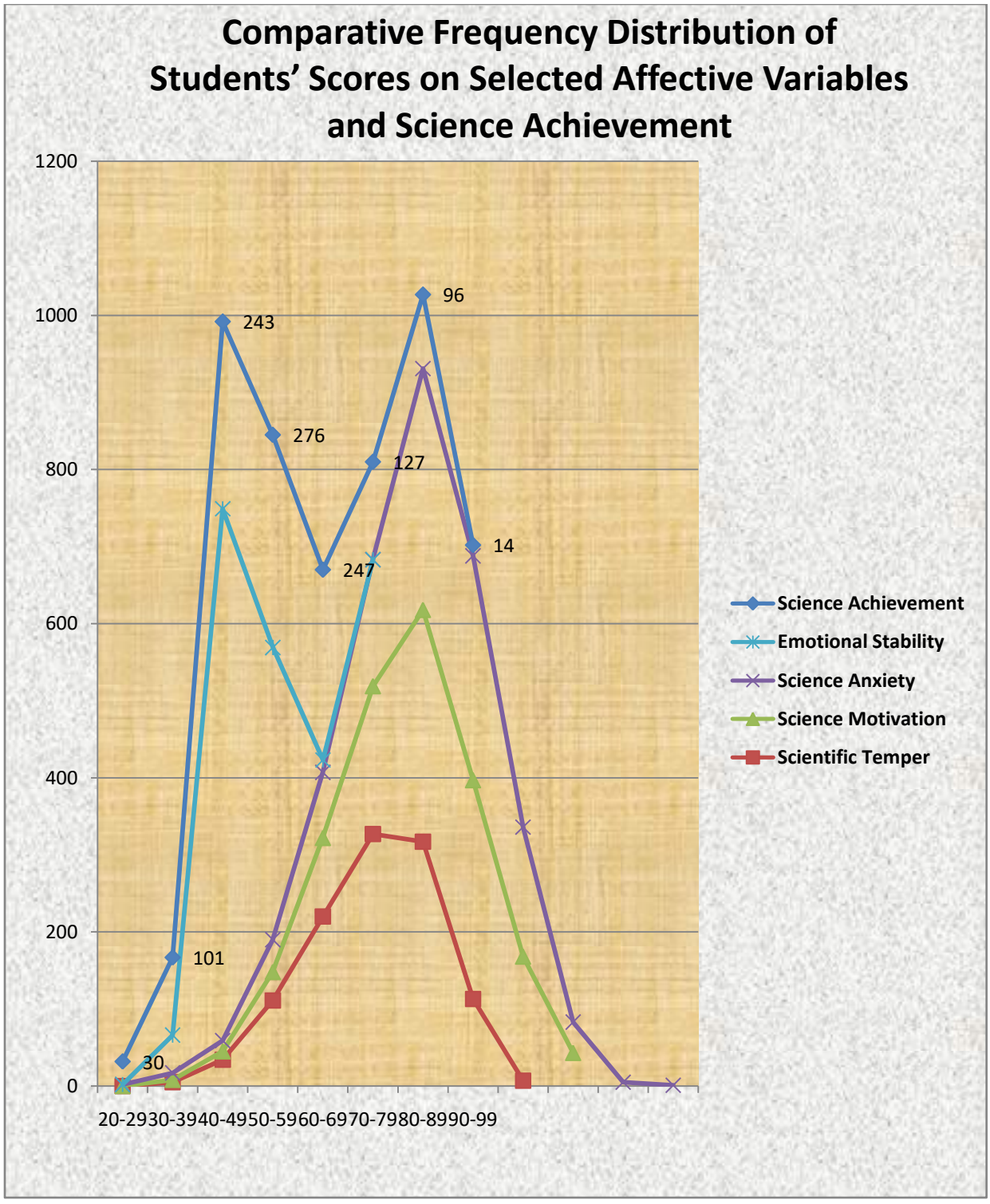

Fig.4.7: Comparative Frequency Distribution of Students' Scores on Selected Affective Variables and Science Achievement

4.1.3FrequencyDistribution of Selected Affective Variables (ST, SM, SA, ES) Among SecondarySchool Students

A further analysis was performed with respect to frequency distribution of students for different levels on affective independent variables as defined in the instruments of their measurement.

A) Frequency distribution of Students' Scientific Temper Scores

Segregation of students' scientific temper scores were done into five levels as defined by Nadeem & Showkat (2008) in the norms of their scientific temper scale. The scientific temper scores of students ranging from 0-50 were divided into five categories with scores from 0-9 showing a poor scientific temper, 10-19 showing a below average scientific temper, 20-29 showing an average scientific temper, 30-39 showing an above average scientific temper and scores of 40 & above showing a high scientific temper (Table 4.2)

Table 4.2
Comparative Frequency Distribution of Students' Scores on Scientific Temper

Classification	Score Range	No. of respondents	Percentage	Cumulative %
High Scientific Temper	40 & above	174	15.34%	100%
Above Average Scientific Temper	30-39	642	56.61%	84.65%
Average Scientific Temper	20-29	293	25.84%	28.04%
Below Average Scientific Temper	10-19	25	2.2%	2.2%
Poor Scientific Temper	0-9	0	0%	0%

Source: Field data

With reference to Table 4.2, it can be said that only 28.04% of the total students seem to possess scientific temper of average and below average level with no student falling into the category of poor scientific temper which is a very welcoming scenario. A majority of students, approximately 72% of them possess an above average and high degree of scientific attitude which is a desirable figure. The students with above average scientific temper were found to be maximum in the sample population with a total percentage of 56.61 %. Fig.4.8 depicts the comparative distribution of students on different levels of scientific temper.

A further comparison of mean science scores of obtained four categories of students segregated on the basis of their scientific temper levels (Fig.4.9) revealed that students possessing high scientific temper scored highest mean score in science of 62.27 (M=62.27, SEM=1.132) followed by students possessing above average scientific temper with a mean score in science of 59.42 (M=59.42, SEM=0.5609). The students with average scientific temper also performed averagely in science with a mean score of 49.99 (M=49.99, SEM=0.8162) followed with students with below average scientific temper which had a science average score of 41.92 (M=41.92, SEM=2.135). The comparison between mean science score of below average scientific temper group students with other groups revealed that significant difference exist with average group ($P<0.05$), above average group ($P<0.001$) and high scientific temper group ($P<0.001$). A similar comparison between mean science score of average scientific temper group students with other group revealed that significant difference exist with above average group ($P<0.001$) and high scientific temper group ($P<0.001$). However, no significant difference was observed between the mean science score of above average and high scientific temper group ($P>0.05$). This indicates that both above average and high scientific temper students where more or less equivalent in their science

achievement profile but significantly differed in science achievement from that of average and below average scientific temper group students. The average and below average scientific temper groups also significantly differed on their mean science achievement scores.

B) Frequency distribution of Students' Science Motivation Scores

An analysis was performed where the students' science motivation scores were segregated into five levels of motivation. The SMQ (Science Motivation Questionnaire) II by Glynn et al. (2011) does not specify the general science motivation levels as it is standardized on American sample but five motivational factors' can be classified into different levels of motivation. Students respond to each item on a rating scale of temporal frequency: never (0), rarely (1), sometimes (2), often (3), or always (4). The possible score range on each of the five 5-item scales is 0–20. For an individual student, on any of the five 5-item scales, he or she can be put into a degree of science motivation by dividing their scale score (0-20) by 5. For example, a student with an intrinsic motivation scale score of 12 (out of 20) is "sometimes to often" intrinsically motivated 12/5 = 2.4. A similar attempt to classify the total scores (range 0-100) into five levels of motivation was done. Five arbitrary categories of motivation scores were made such that 0 score mean absolute absence of science motivation, score range from 1-25 meant only low science motivation, 26-50 meant an average or moderate level of science motivation, 51-75 meant an above moderate level and 76-100 meant a high level of science motivation. There were no students with 0 score and the least score was of 12. There were only 5 students had science motivation score between1-25. 148 students scored from 26-50, 653 students scored from 51-75 which were maximum followed by 328 students scoring from 76-100. The highest science motivation score was that of 100. (Table 4.3)

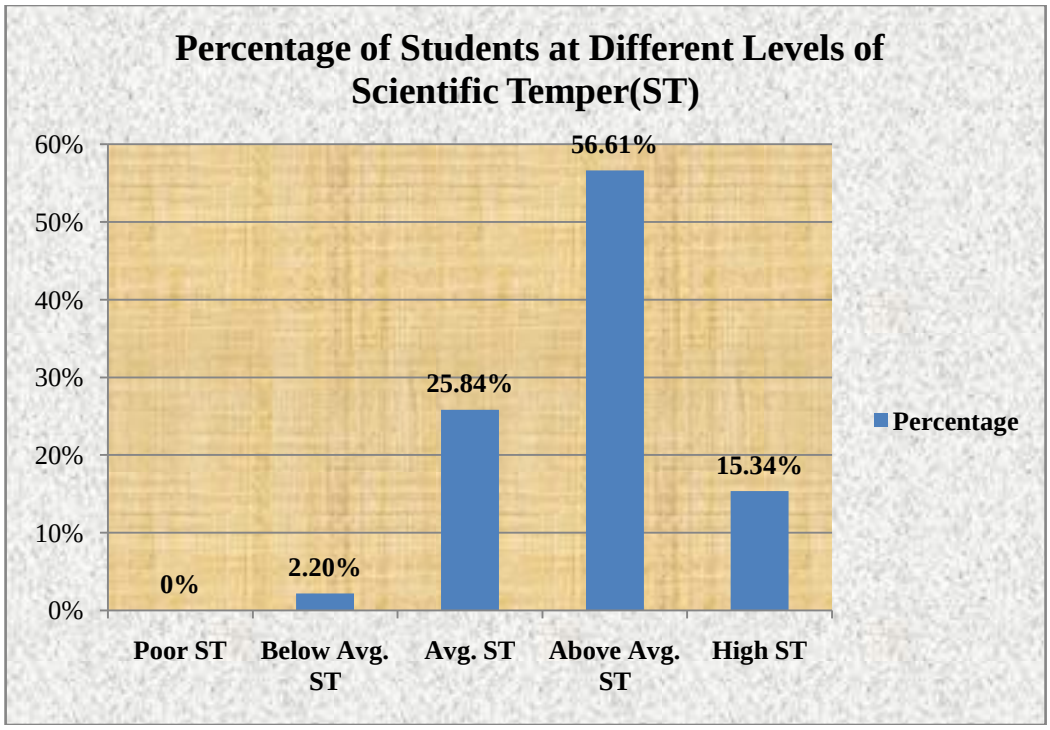

Fig.4.8: Percentage of Students at Different Levels of Scientific Temper(ST)

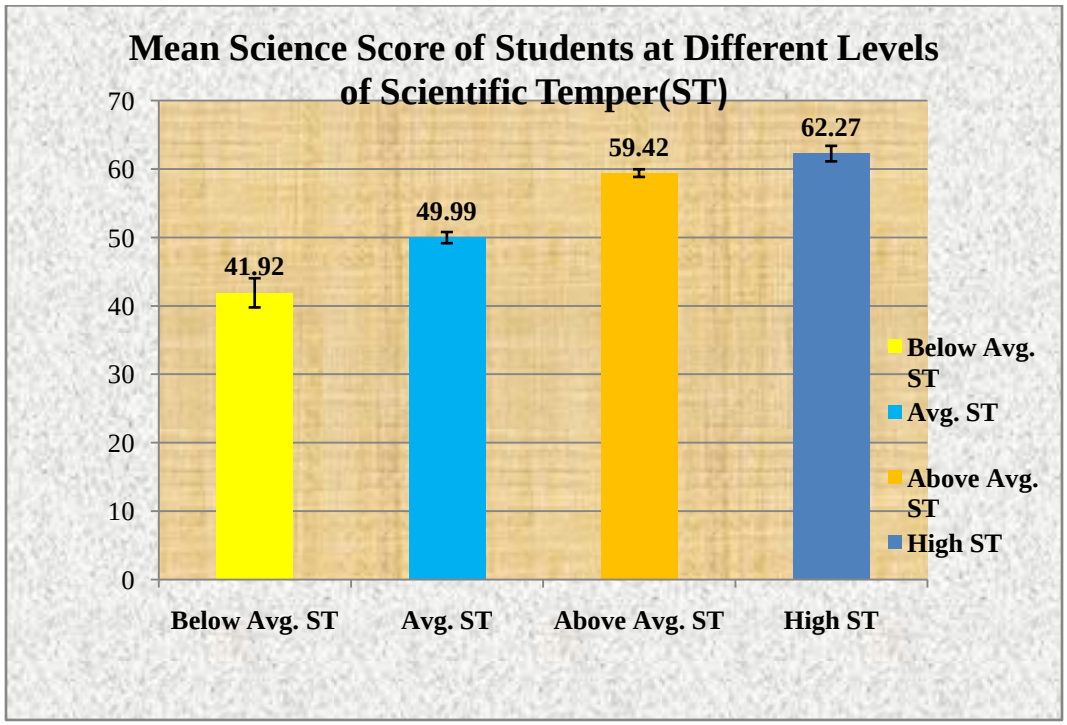

Fig.4.9: Mean Science Score of Students at Different Levels of Scientific Temper(ST)

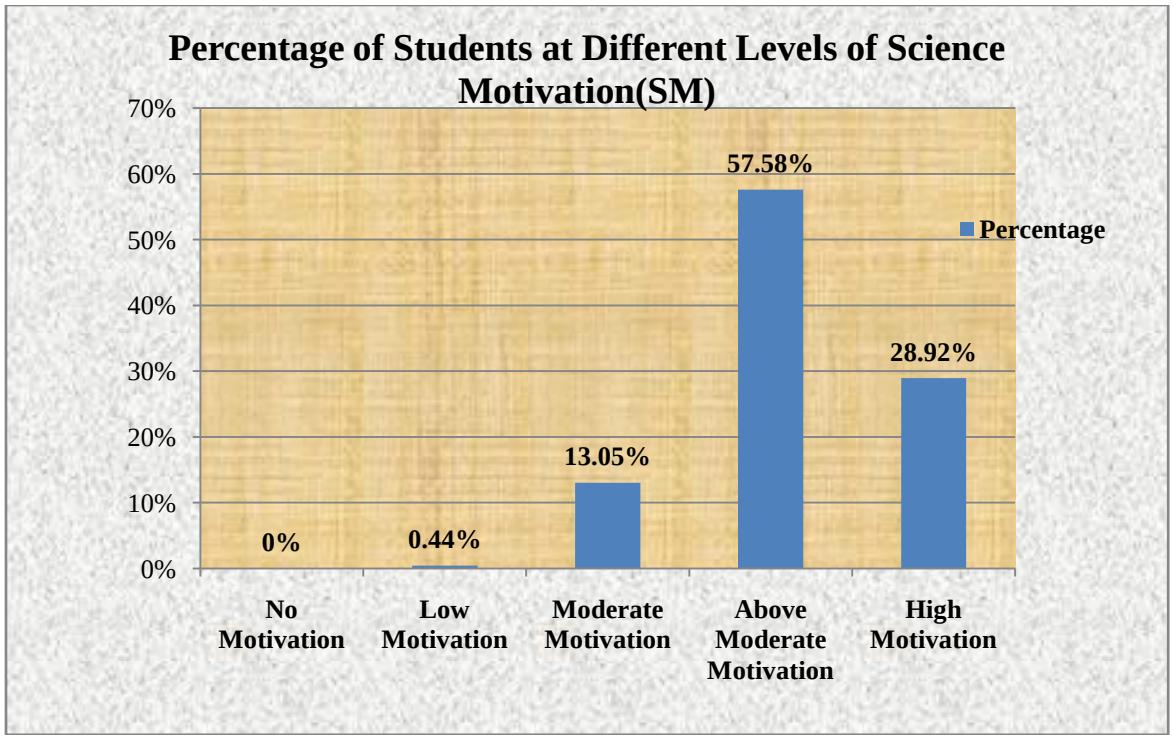

Fig.4.10: Percentage of Students at Different Levels of Science Motivation(SM)

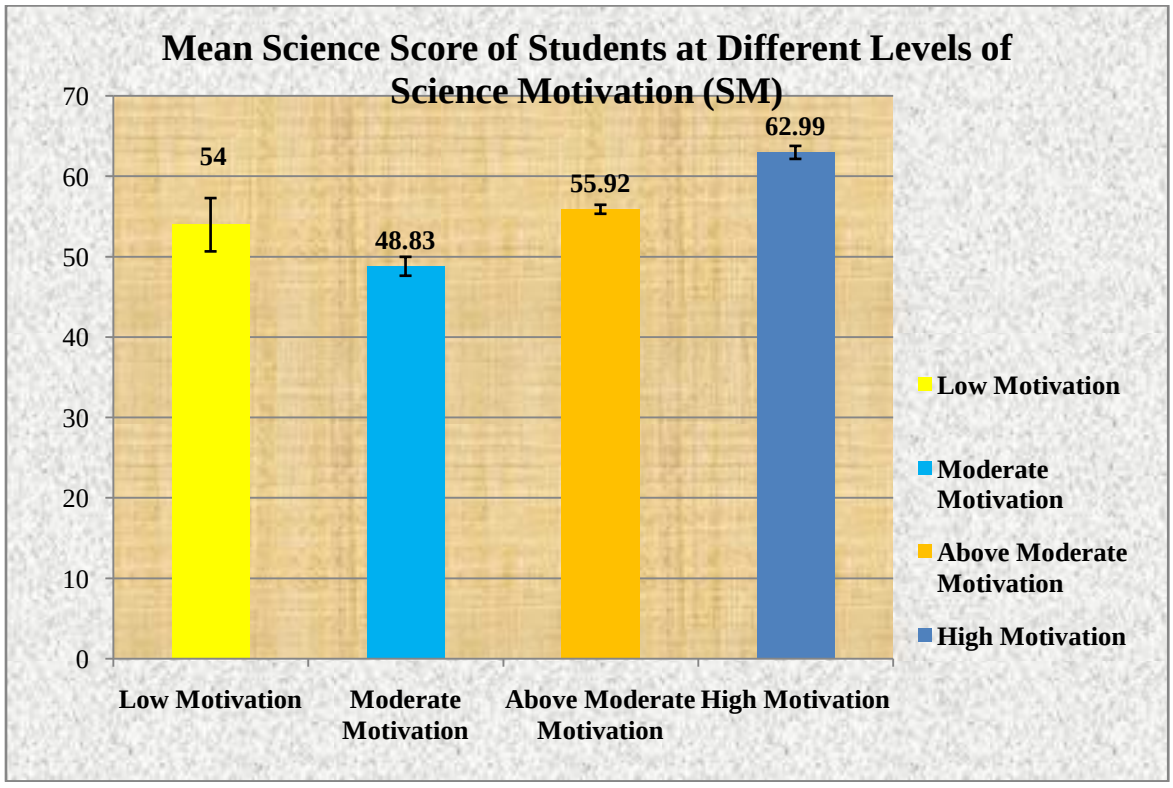

Fig.4.11: Mean Science Score of Students at Different Levels of Science Motivation (SM)

Table 4.3

Comparative Frequency Distribution of Students' Scores on Science Motivation

Classification	Score Range	No. of respondents	Percentage	Cumulative %
High Motivation	76-100	328	28.92%	100%
Above Moderate Motivation	51-75	653	57.58%	71.07%
Moderate Motivation	26-50	148	13.05%	13.49%
Low Motivation	1-25	5	0.44%	0.44%
No Motivation	0	0	0%	0%

Source: Field data

With reference to Table 4.3, it can be said that only 28.92% of the total students possess high science motivation and 57.58% of students possess above moderate level of science motivation together accounting for 86.5 % of the total students. This figure indicates that the sample population has an above average level of science motivation in general which is a very favorable condition for improving science achievement. There were no students with absence of science motivation and only five students possessed a low science motivation score. Nearly 13.05% students possessed a moderate level of science motivation. Fig.4.10 depicts the comparative distribution of students in different levels of science motivation.

A comparison of mean science scores of all the five categories of students segregated on the basis of their science motivation levels (Fig.4.11) revealed that students possessing low science motivation (M= 54, SEM=3.317) did not differed significantly ($P>0.05$) from any of the other groups. Rest three groups significantly differed ($P<0.001$) from each other in their mean science score. The mean score of moderate motivation group being the least (M= 48.83, SEM=1.177), the above moderate level had the second highest (M= 55.92, SEM=0.5601) and the high science motivation group had maximum mean science score (M= 62.99, SEM=0.8083).

C) Frequency distribution of Students' Science Anxiety Scores

The SAQ (Science Anxiety Questionnaire) is an adoption of scale by Czerniak & Chiarelott, 1984 with indigenous modification. An attempt was performed where the students' science anxiety scores were segregated into five levels of science anxiety. Science anxiety scores of students ranging from 30-150 were divided into five categories with scores from 30-54 revealing low, 55-79 revealing below moderate, 80-104 revealing a moderate , 105-129 revealing an above moderate and 111-150 revealing high science anxiety levels. (Table 4.4)

Table 4.4

Comparative Frequency Distribution of Students' Scores on Science Anxiety

Classification	Score Range	No. of respondents	Percentage	Cumulative %
High Science Anxiety	130 & above	6	0.53 %	100%
Above Moderate Science Anxiety	105-129	345	30.42%	99.47%
Moderate Science Anxiety	80-104	631	55.64%	69.05%
Below Moderate Science Anxiety	55-79	133	11.73%	13.41%
Low Science Anxiety	30-54	19	1.68%	1.68%

Source: Field data

With reference to Table 4.4, it is evident that maximum students (55.64 %) possessed a moderate level of science anxiety with a good percentage of above moderate science anxiety (30.42%) and a comparatively less percentage of below moderate science anxiety (11.73%) levels in the sample population. A relatively negligible percentage of students (0.53%) had a low science anxiety level and a comparatively more percentage of students (1.68%) showed high science anxiety level. Fig.4.12 depicts the comparative distribution of students in different levels of science anxiety.
A comparison of mean science scores of low, below moderate, moderate, above moderate and high science anxiety group (Fig.4.13) revealed that both moderate (M= 57.44, SEM=0.5989)and above moderate(M= 58.01, SEM=0.7497) science anxious groups showed better performance in science compared to both high (M= 50.67, SEM=6.048) and low (M= 51.11, SEM=3.875) anxious group and below moderate (M= 53.69, SEM=1.474) science anxious group. However, there is no significant difference observed across all the groups for their mean science achievement scores except between above and below moderate science anxious groups where there is a significant difference observed in their mean science achievement scores ($P < 0.05$). Interestingly the above moderate level of science anxiety favors the students for their high mean science achievement scores than the below moderate science anxious group. But a very high anxiety level leads to reduction in science achievement as observed through the present data.

D) Frequency distribution of Students' Emotional Stability Scores

The emotional stability scores of student ranged from 30-81. The students' scores were divided equally into five categories such that students scoring from 30-40 were considered to possess a low emotional stability, students scoring from 41-50 were considered to be below moderate emotionally stable, students scoring from 51-60 were considered to be moderately emotionally stable, students scoring from 61-70 were considered to be below moderate emotionally stable and those possessing scores from 71-81 were marked as highly emotionally stable (Table 4.5).

Table 4.5
Comparative Frequency Distribution of Students' Scores on Emotional Stability

Classification	Score Range	No. of respondents	Comparative %	Cumulative %
High Emotional Stability	71-81	11	0.97 %	100%
Above Moderate Emotional Stability	61-70	300	26.46%	99.04%
Moderate Emotional Stability	51-60	740	65.26%	72.58%
Below Moderate Emotional Stability	41-50	83	7.32%	7.32%
Low Emotional Stability	30-40	0	0 %	0 %

Source: Field data

With reference to Table 4.5, it is visible that more than half of majority (65.26%) possess a moderate level of emotional stability which is a very good sign of their mental profile. There are relatively less

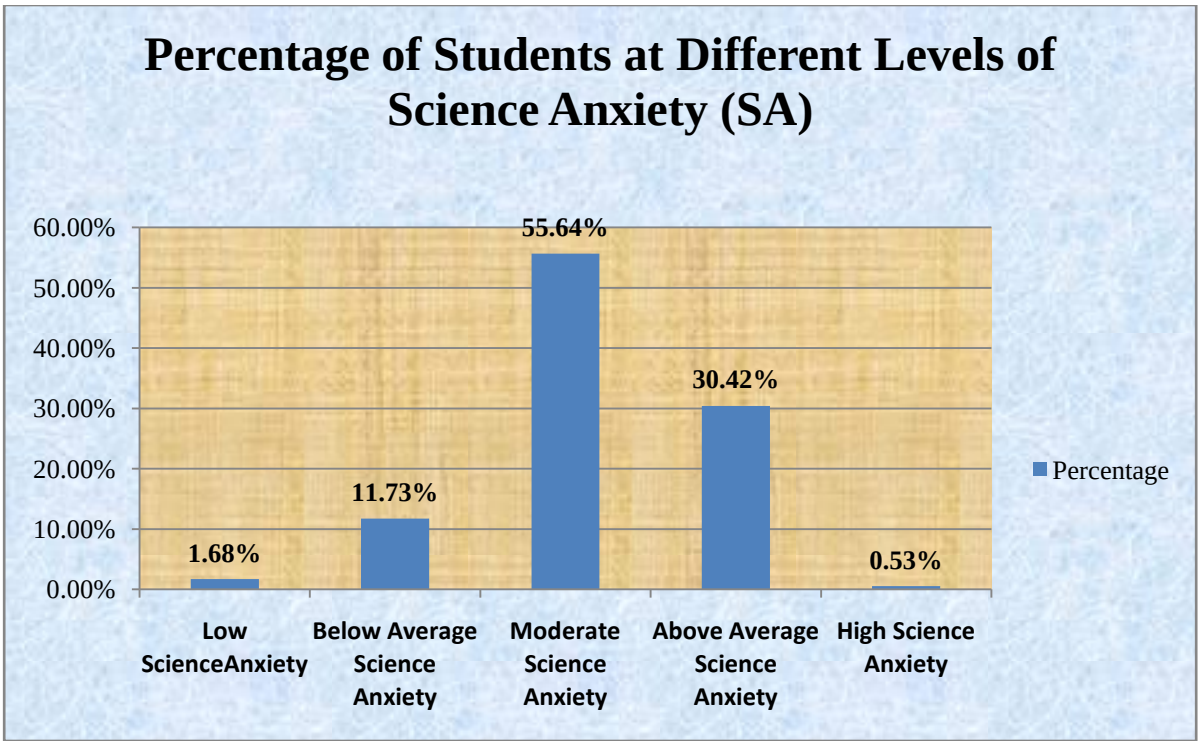

Fig.4.12: Percentage of Students at Different Levels of Science Anxiety (SA)

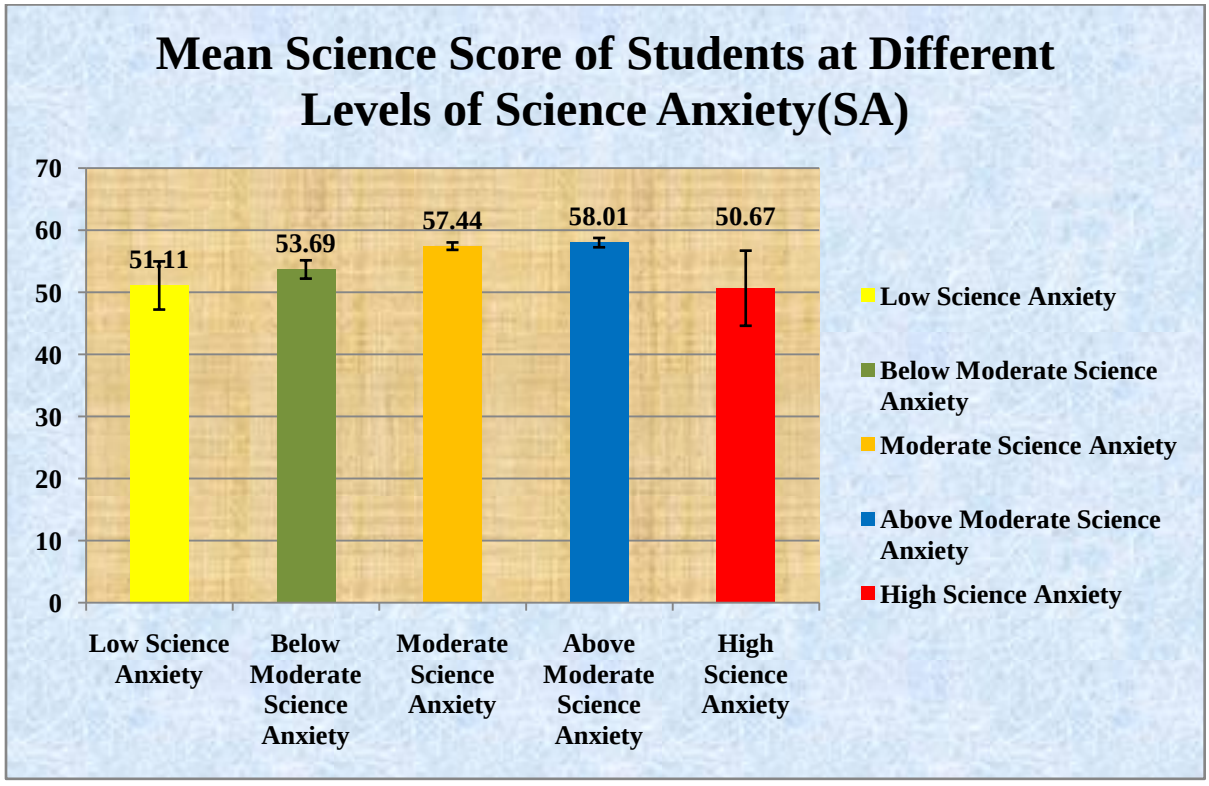

Fig.4.13: Mean Science Score of Students at different levels of Science Anxiety (SA)

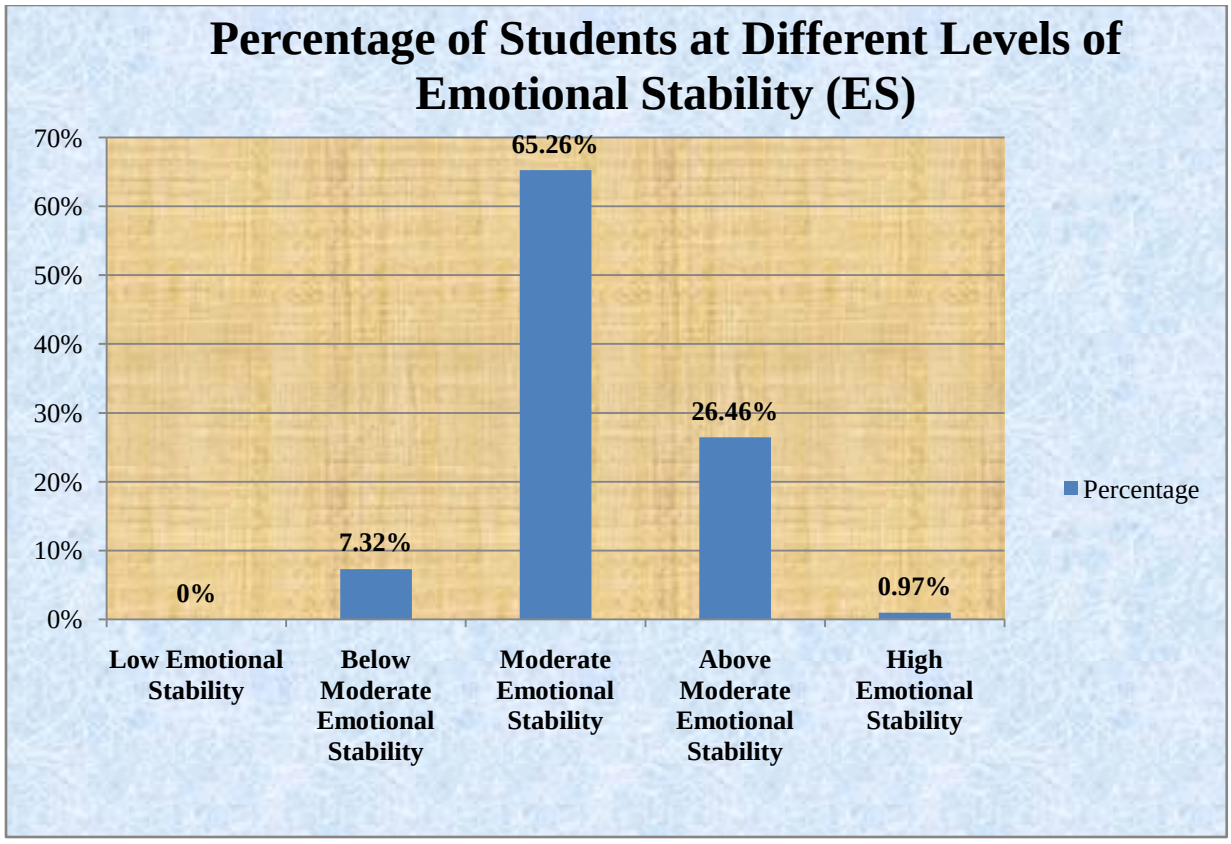

Fig.4.14: Percentage of Students at Different Levels of Emotional Stability (ES)

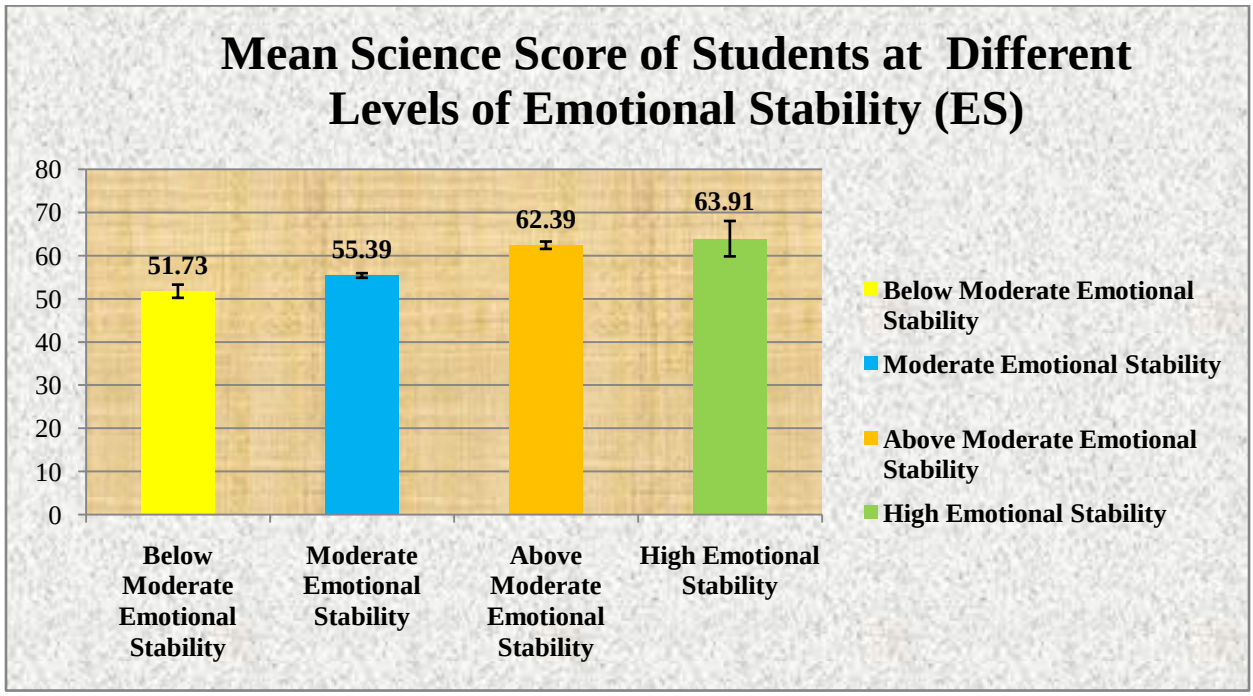

Fig.4.15: Mean Science Score for different levels of Emotional Stability (ES)

students in below moderate (7.32%) emotional stability level and no student is found to possess a low emotional stability level but there are relatively more students to possess above moderate emotional stability (26.46%) and 11 students scored above 70 in their emotional stability scores (0.97%). Fig.4.14 depicts the comparative distribution of students in different levels of emotional stability.
A comparison of mean science scores of below moderate, moderate, above moderate and high emotional stability group (Fig. 4.15) reveals that as the emotional stability of the group improves they tend to perform better in science. The group with below moderate emotional stability (M=51.73, SEM=1.531) did not differed significantly (P>0.05) from moderate (M= 55.39, SEM=0.5397) but differs significantly both with above moderate (M= 62.39, SEM=0.8548); (P< 0.001) and high (M= 63.91, SEM=4.102); (P< 0.05) emotional stability groups. Similarly the moderate and above moderate emotional stability groups differed significantly (P< 0.001) from each other in the mean science achievement scores. However there is no significant difference in mean science achievement scores between moderate and high emotional stability groups and also between above moderate and high emotional stability groups (P>0.05). These comparisons revealed that better levels of emotional stability of students contribute towards the science achievement levels.

4. 2Differential Analysis

This section is majorly about ***Hypothesis testing,*** wherein all the assumed null hypotheses were tested for their validity by the application of appropriate statistical procedure.
In this section the data was subjected to differential analysis by applying student t-test (independent) and chi-square test of association. The data was compared on the basis of levels of scientific temper, science motivation, science anxiety and emotional stability of higher secondary students in relation to their science achievement and gender. The section is further divided into two sub sections. Former section relates to analysis in relation to science achievement and later section deals with analysis in relation to gender.

A) Differential Analysis in Relation to Science Achievement

4.2.1 Comparison of High and Low Achievers in Science in Secondary Schools in Relation to their ST, SM, SA & ES.

This section deals with objectives related to comparison of high and low achievers in science on all the affective variables of scientific temper, science motivation, science anxiety and emotional stability.For the purpose of identifying the high and low achievers in the sample students' science achievement scores were arranged in descending order such that marks were arranged from highest to lowest. The upper 27% of the sample i.e. top 306 sample was identified as the high achievers and similarly the lower 27% of the sample i.e. the bottom 306 sample was identified as the low achievers. Objective wise analysis has been performed to test the proposed null hypotheses.

a)To compare the high and low achievers in science in relation to their scientific temper
The research questions guided to propose the following null hypothesis:
Ho:*-There is no significant difference between high and low achievers in science with respect to scientific temper.*
The scientific temper scores of the two groups were subjected to differential analysis. For the testing of hypothesis student 't' test (independent sample) was performed (Table 4.6).

Table-4.6
Significance of Difference between High and Low Achievers in Science in Relation to their Scientific Temper

Group	Number	Mean	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
High Achievers	306	35.363	5.108	0.2920	11.14	610	S**	Rejected
Low Achievers	306	30.013	6.665	0.3810				

Source: Field data, ** The test suggests that the difference between the two means is extremely significant at 0.01 level.

Interpretation of data: A reference to Table-4.6 reveals that there is statistically significant difference between the mean scientific temper scores of high achievers in science (M= 35.363, SD=5.108) and mean scientific temper scores of low achievers in science (M=30.013, SD=6.665); the obtained t value (11.14) was found extremely significant at 0.01 level with degree of freedom 610, 't' critical value(2.576) being < obtained 't' value. It means that scientific temper of secondary school students vary between low and high achievers. Hence the null hypothesis was rejected. Scientific temper of high achievers is greater than that of low achievers which suggests that a good level of scientific temper is a pre-requisite for good performance in science.

To have a deeper understanding of the differences of high and low achievers in science in term of their scientific temper, further analysis was performed where the students' response on scientific temper were categorized into five dimensions of the scientific temper scale. As already mentioned the scale comprises of ten items each under the dimension 'curiosity', 'open mindedness', 'objectivity', 'rationality' and 'aversion to superstition' making a total of fifty items. Each dimension has a score range of 0-10 which means minimum score obtained under each dimension can be 0 and maximum score can be 10. Frequency distribution of the average score of students on each dimension of scientific temper was analyzed using percentages (Fig.4.16). The findings revealed that students scored maximum under 'objectivity' dimension with mean value of 8.09 followed by 'curiosity', 'rationality, 'open-mindedness' and minimum under 'aversion to superstition' with mean value of 4.52. The comparative mean scores obtained on all the five dimensions are summarized in Table 4.7.

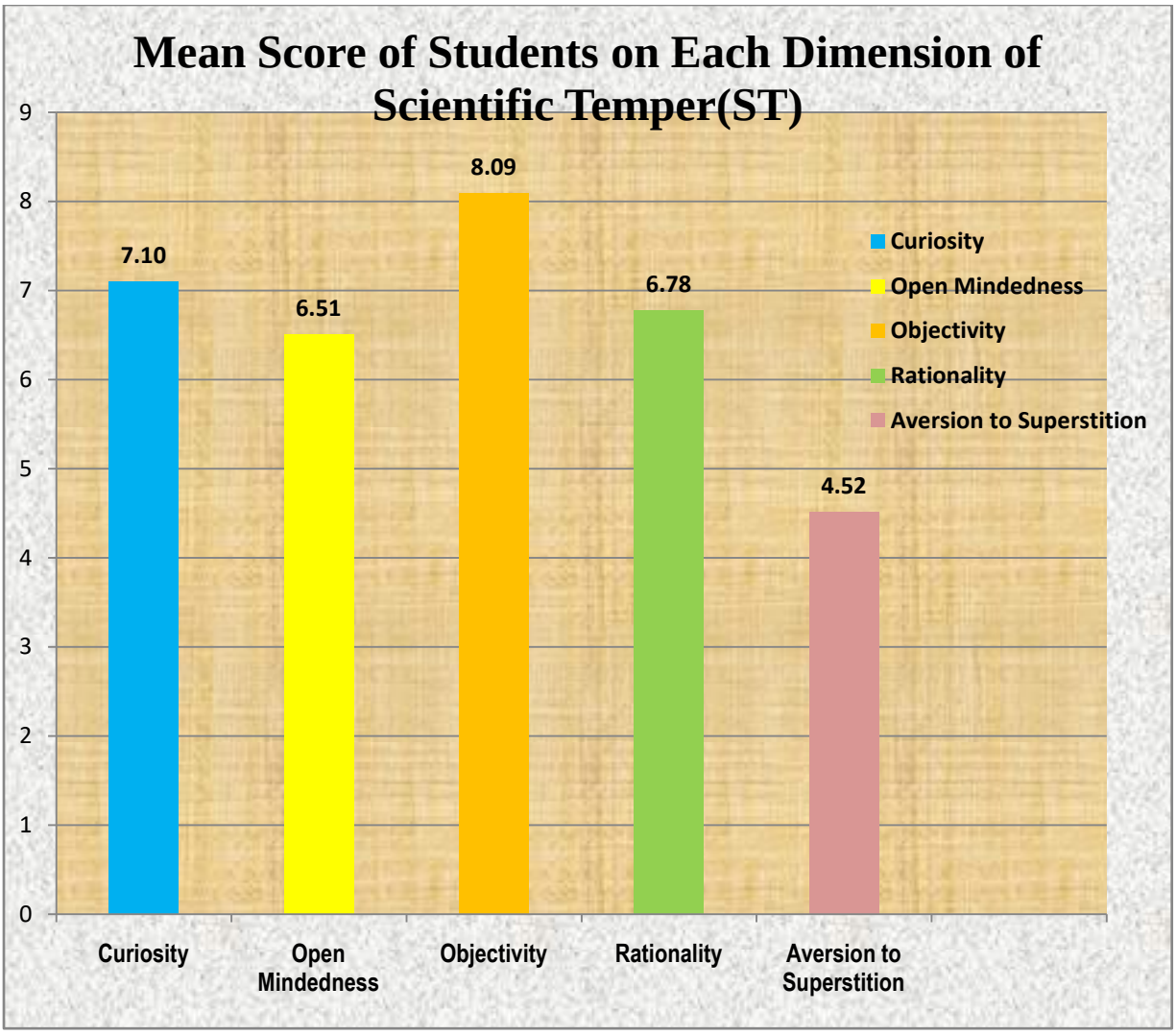

Fig.4.16: Mean Score of Students on each Dimension of Scientific Temper(ST)

Table4.7

Mean Score of Students on each Dimension of Scientific Temper

Dimensions of ST	Mean Score on each dimension of Scientific Temper
Curiosity (0-10)	7.10
Open mindedness(0-10)	6.51
Objectivity(0-10)	8.09
Rationality(0-10)	6.78
Aversion to Superstition(0-10)	4.52

Further, student t-test (independent) was performed to compare the high and low science achievers for their scientific temper levels on each dimension. For the purpose of testing following null hypotheses were proposed.

Ho1:*-There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'Curiosity'*

Ho2:*-There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'Open mindedness'*

Ho3:*-There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'Objectivity'*

Ho4:*-There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'Rationality'*

Ho5:*-There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'Aversion to superstition'*

Table- 4.8 depicts the results of the hypothesis testing.

Table 4.8

Significance of Difference between High and Low Achievers in Science in Relation to their Means on Different Dimensions of Scientific Temper

Dimensions	Groups	Number	Mean (M)	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
1. *Curiosity*	High Achievers in Science	306	7.36	1.585	0.09062	4.758	610	S** (0.01)	***Ho1*** Rejected
	Low Achievers in Science	306	6.74	1.643	0.09391				
2. *Open mindedness*	High Achievers in Science	306	7.24	1.582	0.09045	10.394	610	S** (0.01)	***Ho2*** Rejected
	Low Achievers in Science	306	5.71	2.023	0.1157				
3.*Objectivity*	High Achievers in Science	306	8.57	1.290	0.07372	9.345	610	S** (0.01)	***Ho3*** Rejected
	Low Achievers in Science	306	7.35	1.868	0.1068				
4.*Rationality*	High Achievers in Science	306	7.22	1.363	0.07794	8.223	610	S** (0.01)	***Ho4*** Rejected
	Low Achievers in Science	306	6.19	1.731	0.09898				
5. *Aversion to Superstition*	High Achievers in Science	306	4.98	1.961	0.1121	5.974	610	S** (0.01)	***Ho5*** Rejected
	Low Achievers in Science	306	4.02	1.991	0.1138				

***Source: Field data,** The test suggests that the difference between the two means is extremely significant at 0.01 level*.

Interpretation of data: A reference to Table 4.8 shows that for all the five dimensions of Scientific Temper Scale there is statistically significant difference between the mean scientific temper scores of high and low achievers in science which are Curiosity [t(610)=4.758, p<0.0001)], Open Mindedness [t(610)=10.394, p<0.0001)], Objectivity [t(610)=9.345, p<0.0001)] , Rationality [t(610)=8.223, p<0.0001)] and Aversion to Superstition [t(610)=5.974, p<0.0001)]. In all the dimensions the high achievers in science differed significantly with higher mean scientific temper score than those of low achievers. Hence *Ho1,Ho2,Ho3, Ho4* and *Ho5* were rejected.

b) To compare the high and low achievers in science in relation to their science motivation.

The research questions guided to propose null hypothesis which is as follows:

Ho:*-There is no significant difference between high and low achievers in science with respect to science motivation.*

The science motivation scores of the two groups were subjected to differential analysis. For the testing of hypothesis student 't' test (independent sample) was performed (Table 4.9).

Table 4.9
Significance of Difference between High and Low Achievers in Science in Relation to their Science Motivation

Group	Number	Mean	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
High Achievers	306	72.327	13.484	.7708	10.68	610	S**	Rejected
Low Achievers	306	60.307	14.350	.8204				

Source: Field data, **The test suggests that the difference between the two SDs is extremely significant at 0.01 level.

Interpretation of data: A reference to Table 4.9 reveals that there is statistically significant difference between the mean science motivation scores of high achievers in science (M=72.327, SD=13.484) and mean science anxiety scores of low achievers in science (M=60.307, SD=14.350); the obtained t value (10.68) was found extremely significant at 0.01 level with degree of freedom 610, 't' critical value(2.576) being < obtained 't' value. It means that science motivation of secondary school students vary between low and high achievers. Hence the null hypothesis was rejected. The science motivation of high achievers is greater than that of low achievers which suggest that highly science motivated students tend to perform better in science.

To have more clear-cut understanding of the differences of high and low achievers in science in term of their science motivation, further analysis was performed where the students' response on science motivation were categorized into five dimensions of the SMQ II. As already mentioned the scale comprises of five items under its each dimension 'intrinsic motivation', 'career motivation', 'self-determination', 'self-efficacy' and 'grade motivation'. Each dimension is measured through 5 items with a score range of 0-20. It means minimum score obtained under each dimension can be 0 and maximum score can be 20. Frequency distribution of the average score of students on each dimension of science motivation was analyzed using percentages (Fig.4.17). The findings revealed that students scored maximum under 'grade motivation' dimension with mean value of 14.98 followed by 'career motivation', 'intrinsic motivation', 'self-efficacy' and minimum under 'self-determination' with mean value of 11.18. The comparative mean scores obtained on all the five dimensions are summarized in Table 4.10

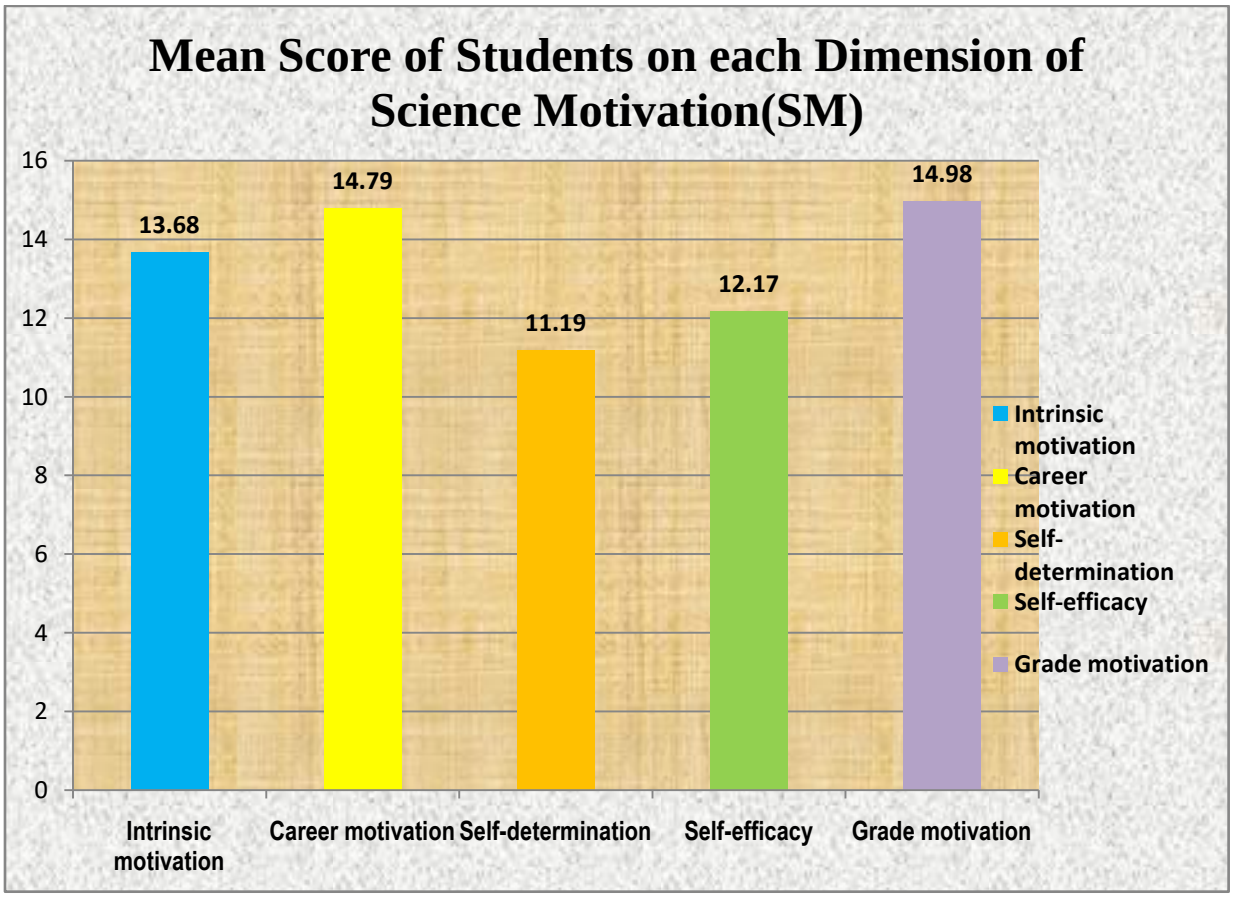

Fig.4.17: Mean Score of Students on each Dimension of Science Motivation(SM)

Table 4.10

Mean Score of Students on each Dimension of Science Motivation

Dimensions of SM	Mean Score on each Dimensionof Science Motivation
Intrinsic Motivation (0-20)	13.68
Career Motivation (0-20)	14.79
Self-Determination(0-20)	11.19
Self-Efficacy(0-20)	12.17
Grade Motivation (0-20)	14.98

Further, student t-test (independent) was performed to compare the high and low science achievers for their science motivation levels on each dimension. For the purpose of testing following null hypotheses were proposed.

Ho1:*-There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Intrinsic motivation'*

Ho2:*-There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Career motivation'*

Ho3:*-There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Self-determination'*

Ho4:*-There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Self-efficacy'*

Ho5:*-There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Grade motivation'*

Table 4.11 depicts the results of the hypothesis testing.

Table 4.11

Significance of Difference between High and Low Achievers in Science in Relation to their Means on Different Dimensions of Science Motivation

Dimensions	Groups	Number	Mean (M)	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
Intrinsic Motivation	High achievers in Science	306	14.56	3.497	0.1999	6.657	610	S**(0.01)	***Ho1*** Rejected
	Low achievers in Science	306	12.67	3.535	0.2021				
Career Motivation	High achievers in Science	306	15.91	3.754	0.2146	8.114	610	S**(0.01)	***Ho2*** Rejected
	Low achievers in Science	306	13.31	4.138	0.2365				
Self-Determination	High achievers in Science	306	11.98	3.670	0.2098	5.879	610	S**(0.01)	***Ho3*** Rejected
	Low achievers in Science	306	10.29	3.449	0.1972				
Self-Efficacy	High achievers in Science	306	13.23	3.719	0.2126	8.043	610	S**(0.01)	***Ho4*** Rejected
	Low achievers in Science	306	10.69	4.073	0.2329				
Grade Motivation	High achievers in Science	306	16.64	3.260	0.1864	11.575	610	S**(0.01)	***Ho5*** Rejected
	Low achievers in Science	306	13.25	3.950	0.2258				

Source: Field data, ** The test suggests that the difference between the two means is extremely significant at 0.01 level.

Interpretation of data: A reference to Table 4.11 shows that for all the five dimensions of SMQ II there is statistically significant difference between the mean science motivation scores of high and low achievers in science which are Intrinsic motivation [t(610)=6.657, p<.0.0001)], Career motivation [t(610)=8.114, p<.0.0001)], Self-determination [t(610)=5.879, p<.0.0001)] , Self-efficacy[t(610)=8.043, p<.0.0001)] and Grade motivation[t(610)=11.575, p<.0.0001)]. In all the dimensions the high achievers in science differed significantly with higher mean science motivation score than those of low achievers. Hence *Ho1, Ho2, Ho3, Ho4* and *Ho5*wererejected.

c) To compare the high and low achievers in science in relation to their science anxiety.
The research questions guided to propose null hypothesis which is as follows:
Ho:*-There is no significant difference between high and low achievers in science with respect to science anxiety.*
The science anxiety scores of the two groups were subjected to differential analysis. For the testing of hypothesis student 't' test (independent sample) was performed (Table 4.12).

Table 4.12
Significance of Difference between High and Low Achievers in Science in Relation to their Science Anxiety

Group	Number	Mean	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
High Achievers	306	97.556	14.261	.8152	3.90	610	S**	Rejected
Low Achievers	306	92.788	15.940	.9113				

Source: Field data, **The test suggests that the difference between the two means is extremely significant at 0.01 level.

Interpretation of data: A reference to Table 4.12 reveals that there is statistically significant difference between the mean science anxiety scores of high achievers in science (M= 97.56, SD=14.26) and mean science anxiety scores of low achievers in science (M= 92.79, SD=15.94); the obtained t value (3.90) was found extremely significant at 0.01 level with degree of freedom 610, 't' critical value(2.576) being < obtained 't' value. It means that science anxiety of secondary school students vary between low and high achievers. Hence the null hypothesis was rejected. Interestingly, the science anxiety of high achievers is greater than that of low achievers which agrees with the fact that science anxiety at its minimal levels does not interferes with student's performance in science.
To dig in further it was decided to analyze the differences between high and low achievers in science with respect to the six dimensions against which science anxiety of students was measured using Science Anxiety Questionnaire (SAQ). As already mentioned under every dimension five items were kept making a total of thirty items. Each dimension has a score range of 5-25. Frequency distribution on average score of students on each dimension of science anxiety was analyzed using percentages (Fig.4.18). The findings revealed that students scored maximum for 'fear of testing' dimension with mean value of 18.08 followed by 'performance in front of others', 'content mastery', 'parents' expectation', 'teacher's behavior…' and minimum for 'application of science' with mean value of 14.49. The findings further revealed that except 'Fear of Testing' dimension on all other dimensions students were found to be moderately science anxious. It means 'fear of testing' dimension contributed maximally to their science anxiety. The comparative mean scores obtained on all the six dimensions are summarized in Table 4.13

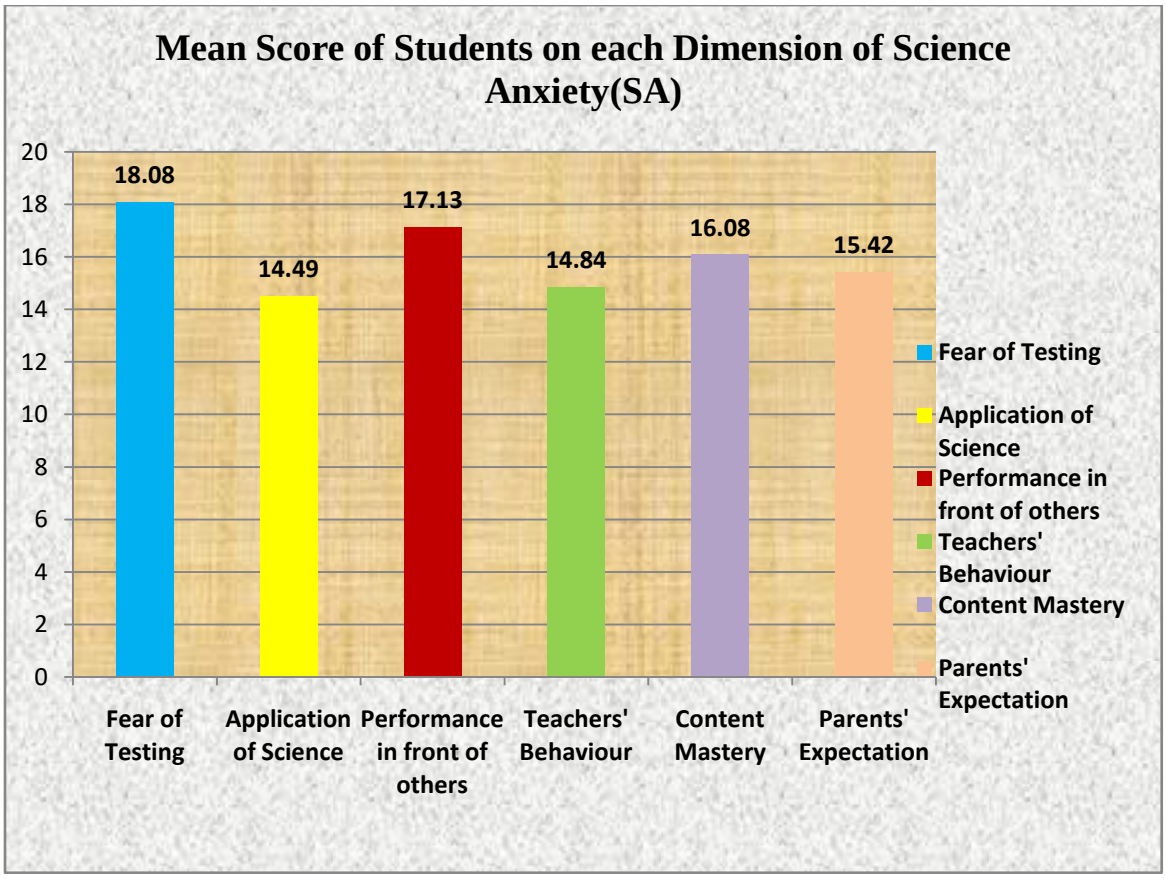

Fig.4.18: Mean Score of Students on each Dimension of Science Anxiety(SA)

Table 4.13
Mean Score of Students on each Dimension of Science Anxiety

Dimensions of SA	Mean Score on each dimension of Science Anxiety
Fear of testing (1-25)	18.08
Application of Science (1-25)	14.49
Performance in front of others (1-25)	17.13
Teachers' behaviour... (1-25)	14.84
Content mastery(1-25)	16.08
Parents' expectation (1-25)	15.42

Further, student t-test (independent) was performed to compare the high and low science achievers for their science anxiety levels on each dimension. For the purpose of testing following null hypotheses were proposed.

Ho1:*-There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Fear of testing'*

Ho2:*-There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Application of science'*

Ho3:*-There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Performance in front of others'*

Ho4:*-There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Teachers' behaviour, teaching style and teaching environment'*

Ho5:*-There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Content mastery'*

Ho6:*-There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Parents' expectation'*

Table 4.14 depicts the results of the hypothesis testing.

Table 4.14

Significance of Difference between High and Low Achievers in Science in Relation to their Means on Different Dimensions of Science Anxiety

Dimensions	Groups	Number	Mean (M)	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
Fear of testing	High Achievers in Science	306	19.23	3.489	0.1995	9.28*	610	S**(0.01)	***Ho1*** Rejected
	Low Achievers in Science	306	16.51	3.757	0.2148				
Application of science	High Achievers in Science	306	13.65	3.030	0.1732	4.69*	610	S**(0.01)	***Ho2*** Rejected
	Low Achievers in Science	306	14.87	3.411	0.1950				
Performance in front of Others	High Achievers in Science	306	17.79	3.467	0.1982	6.08*	610	S**(0.01)	***Ho3*** Rejected
	Low Achievers in Science	306	15.99	3.867	0.2211				
Teachers' behaviour, teaching style and teaching environment	High Achievers in Science	306	14.60	2.834	0.1620	0.93	610	NS	***Ho4*** Accepted
	Low Achievers in Science	306	14.38	3.140	0.1795				
Content mastery	High Achievers in Science	306	16.21	3.210	0.1835	2.59*	610	S**(0.01)	***Ho5*** Rejected
	Low Achievers in Science	306	15.51	3.464	0.1980				
Parents' expectation	High Achievers in Science	306	15.84	3.829	0.2189	1.08	610	NS	***Ho6*** Accepted
	Low Achievers in Science	306	15.52	3.737	0.2136				

Source: Field data,** ** The test suggests that the difference between the two means is extremely significant at 0.01 level;NS means non-significant at 0.05 level.

Interpretation of data: A reference to Table 4.14 shows that for four dimensions of SAQ there is statistically significant difference between the mean science anxiety scores of high and low achievers in science: Fear of testing [t(610)=9.28, p<.0.01)], Application of science[t(610)=4.69, p<.0.01)], Performance in front of others [t(610)=6.08, p<.0.01)] and Content mastery [t(610)=2.59, p<.0.01)]. On these dimensions high achievers are found more anxious except the dimension 'application of science' on which low achievers are found more anxious. However, there is no significant difference between the mean scores for two dimensions of SAQ: Teachers' behaviour, teaching style and teaching environment [(t (610) =0.93, p>.05)] and Parents' expectation [(t (610)=1.08, p>.05)]. Hence *Ho1, Ho2, Ho3, Ho5* were rejected and *Ho4, Ho6* wereaccepted.

d)To compare the high and low achievers in science in relation to their emotional stability.
The research questions guided to propose null hypothesis which is as follows:

Ho:*-There is no significant difference between low and high achievers in science with respect to emotional stability.*

The emotional stability scores of the two groups were subjected to differential analysis. For the testing of hypothesis student 't' test (independent sample) was performed (Table 4.15).

Table 4.15
Significance of Difference between High and Low Achievers in Science in Relation to their Emotional Stability

Group	Number	Mean	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
High Achievers	306	59.18	5.152	0.2945	7.945	610	S**	Rejected
Low Achievers	306	56.04	4.611	0.2636				

Source: Field data, **The test suggests that the difference between the two means is extremely significant at 0.01 level.

Interpretation: A reference to Table 4.15 reveals that there is statistically significant difference between the mean emotional stability scores of high achievers in science (M=59.18, SD=5.152) and the mean emotional stability scores of low achievers in science (M= 56.04, SD=4.611); obtained t value (7.945) was found extremely significant at 0.01 level with degree of freedom 610,'t' critical value (2.576) being < obtained 't' value. It means that emotional stability of secondary school students vary between low and high achievers. The emotional stability of high achievers is greater than that of low achievers. Hence the null hypothesis is rejected.

Since there are no sub-dimensions in the emotional stability scale no further analysis was possible for this variable

B) Differential Analysis in relation to Gender

This section deals with objectives related to comparison of gender on all the affective variables of scientific temper, science motivation, science anxiety and emotional stability. This section also deals with objectives related to study the impact of gender on science and overall achievement.

For comparing gender on all variables parametric statistical procedure of independent t-test has been applied to test the null hypothesis considering the sample to fulfill the assumptions of randomness and homogeneity. Chi square ($\chi 2$) was used to perform the test of association between gender and various affective constructs of the study.

Objective wise analysis has been performed to test the proposed null hypotheses.

4.2.2 Gender Differences in ST, SM, SA & ES Among Secondary School Students

a) To examine the gender variation in scientific temper amongst the secondary school students.

The research question guided to propose the following null hypotheses:

Ho:*-There is no significant gender difference in secondary school students with respect to their scientific temper.*

Table 4.16 depicts the t-test analysis.

Table 4.16
Significance of Difference between Boys and Girls in Relation to their Scientific Temper

Group	Number(N)	Mean	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
Boys	532	33.169	6.134	.266	0.838*	1132	NS	Accepted
Girls	602	32.854	6.489	.265				

Source: Field data. *The test suggests that the difference between the two means is not significant at 0.05 level.

Interpretation: A reference to Table 4.16 reveals that the obtained t value (0.838) was not found significant at 0.05 level with degree of freedom 1132, 't' critical value(1.960) being > obtained 't' value. It means that scientific temper of secondary school students does not vary with respect to their gender. Hence the null hypothesis is accepted.

Table4.17 depicts the mean and standard deviation scores of students for different dimensions of scientific temper scale.

Table-4.17
Mean and Standard Deviation Values of Boys and Girls on Different Dimensions of Scientific Temper Scale

Dimensions of Scientific Temper Scale	Boys (n=532)	Girls (n=602)	Total (n=1134)
Curiosity	M=7.27	M=6.94	M=7.10
	sd=0.07	sd=1.62	sd=1.63
Open Mindedness	M=6.54	M=6.48	M=6.51
	sd=1.89	sd=2.04	sd=1.97
Objectivity	M=8.11	M=8.08	M=8.09
	sd=1.55	sd=1.69	sd=1.62
Rationality	M=6.72	M=6.83	M=6.78
	sd=1.71	sd=1.63	sd=1.67
Aversion to Superstition	M=4.52	M=4.51	M=4.52
	sd=1.91	sd=2.06	sd=1.99

A reference to Table 4.17 suggests that the mean scores of boys and girls on all the five dimensions of scientific temper did not vary much. However the standard deviation for girls was comparatively higher than boys except for the dimension rationality.

A further analysis was done using chi square test of association to identify the relationship between gender and students' levels on various levels of scientific temper. Following null hypothesis was proposed for the purpose:

Ho:- *There is no significant association between gender and level of scientific temper.*
The chi-square test of independence was employed to test the null hypothesis.
Table 4.18 depicts the $\chi 2$ analysis.

Table 4.18
χ^2 results for Test of Independence between Gender and Level of Scientific Temper

Group	High ST (40 & above)	Above Avg. ST (30-39)	Average ST(20-29)	Below Avg. ST(10-19)	Poor ST (0-9)	Total	Level of Significance	Decision onNull Hypothesis
Boys	Obs. 77 (exp. 81.63)	Obs. 313 (exp. 301.19)	Obs. 130 (exp.137.46)	Obs.12 (exp.11.73)	Obs.0 (exp.0)	532	0.05	Accepted
F_o-F_e	-4.63	11.81	-7.46	0.27	0			
Girls	Obs. 97 (exp.92.37)	Obs.329 (exp.340.81)	Obs.163 (exp.155.54)	Obs.13 (exp.13.27)	Obs. 0 (exp.0)	602		
F_o-F_e	4.63	-11.81	7.46	-0.27	0			
Total	174	642	293	25	0	1134		
$\chi^2 = (F_o-F_e)^2/F_e$		0.23+0.46+0.40+0.006+0.23+0.41+0.36+3.58=**5.706 (*df*=4)** χ^2**=5.706**						

Interpretation of data: The chi-square analysis (Table 4.18) shows that scientific temper is independent of gender. The obtained chi-square value of 5.706 was found insignificant at 0.05 level at 4 *df*, '$\chi^{2'}$ critical value (9.488) being > obtained χ^2 value indicating that there is no definite association between the different levels of scientific temper and gender. Hence the null hypothesis was accepted.

Thus we see both the 't' test and $\chi 2$ analysis reveal that there is no significant difference between the scientific temper of boys and girls.

b) To examine the gender variation in science motivation amongst the secondary school students.

The research question guided to propose the following null hypotheses:

Ho:*-There is no significant gender difference in secondary school students with respect to their science motivation.*
Table 4.19 depicts the t-test analysis

Table 4.19
Significance of Difference between Boys and Girls in Relation to their Science Motivation

Group	Number(N)	Mean	S.D.	SEM	t value	Df	Significance of Difference	Decision on Null Hypothesis
Boys	532	67.938	14.854	.644	2.36	1132	S*	Rejected
Girls	602	65.895	14.282	.582				

Source: Field data. *The test suggests that the difference between the two means is significant at 0.02 level.

Interpretation: A reference to Table 4.19 reveals that the obtained t value (2.36) was found significant at 0.02 level with degree of freedom 1132, 't' critical value(2.326) being < obtained 't' value. It means that science motivation of secondary school students vary with respect to their gender with boys being more science motivated. Hence the null hypothesis is rejected.

Table 4.20 depicts the mean and standard deviation scores of students for different dimensions of Science Motivation Questionnaire (SMQ II).

Table 4.20
Mean and Standard Deviation Values of Boys and Girls on Different Dimensions of Science Motivation Questionnaire

Factors of Science Motivation	Boys (n=532)	Girls (n=602)	Total (n=1134)
Intrinsic motivation	M=14.103	M=13.314	M=13.684
	sd=3.552	sd=3.532	sd=3.562
Career motivation	M=14.881	M=14.723	M=14.797
	sd=3.953	sd=3.976	sd=3.964
Self-determination	M=11.240	M=11.149	M=11.192
	sd=3.678	sd=3.511	sd=3.589
Self-efficacy	M=12.714	M=11.694	M=12.173
	sd=4.048	sd=3.834	sd=3.967
Grade motivation	M=14.951	M=15.015	M=14.985
	sd=3.910	sd=3.795	sd=3.848

A reference to Table 4.20 suggest that the mean scores of boys and girls on all the five dimensions of science motivation differed slightly with boys' average being slightly higher except for the dimension grade motivation where girls had higher mean score. Interestingly, the standard deviation for both boys and girls was almost neck to neck except for dimension self-efficacy where boys had higher mean score and standard deviation than their counterparts.

A further analysis was done using chi square test of association to identify the relationship between gender and students' levels on various levels of science motivation. Following null hypothesis was proposed for the purpose:

Ho:- *There is no significant association between gender and level of science motivation.*

The chi-square test of independence was employed to test the null hypothesis. Table 4.21 depicts the $\chi 2$ analysis.

Table 4.21

χ^2 results for Test of Independence between Gender and Level of Science Motivation

Group	High SM (76-100)	Above Moderate SM (51-75)	Moderate SM(26-50)	Below Moderate SM(1-25)	No SM (0)	Total	Level of Significance	Decision on Null Hypothesis
Boys	Obs. 175 (exp. 153.88)	Obs.298 (exp.306.35)	Obs. 54 (exp.69.43)	Obs.5 (exp.2.35)	Obs.0 (exp.0)	532	0.01	Rejected
F_o-F_e	21.12	-8.35	-15.43	2.65	0			
Girls	Obs.153 (exp.174.12)	Obs.355 (exp.346.65)	Obs.94 (exp.78.57)	Obs.0 (exp. 2.65)	Obs. 0 (exp.0)	602		
F_o-F_e	-21.12	8.35	15.43	-2.65	0			
Total	328	653	148	5	0	1134		
$\chi^2 = (F_o-F_e)^2/F_e$		2.89 + 0.23+3.43+2.99+2.56+0.20+3.03+2.65= 17.98* **(*df*=4)** **χ^2=17.98**						

Interpretation of data: The chi-square analysis (Table 4.21) shows that science motivation is not independent of gender. The obtained chi-square value of 17.98 was found highly significant at 0.01 level at 4 *df*, 'χ^2' critical value (13.277) being < obtained χ^2 value indicating that there is a definite association between the different levels of science motivation and gender. Hence the null hypothesis was rejected.

Here, we see that both the 't' test and $\chi 2$ analysis reveal that there is a significant difference between the science motivation of boys and girls. Interestingly all the students in below moderate level of science motivation having a score range of 1-25, were all boys.

c)To examine the gender variation in science anxiety amongst the secondary school students.

The research question guided to propose the following null hypotheses:

Ho:*-There is no significant gender difference in secondary school students with respect to their science anxiety.*Table 4.22depicts the t-test analysis

Table 4.22

Significance of Difference between Boys and Girls in Relation to their Science Anxiety

Group	Number(N)	Mean	S.D.	SEM	t value	Df	Significance of Difference	Decision on Null Hypothesis
Boys	532	94.84	14.931	.647	3.21	1132	S**	Rejected
Girls	602	97.769	15.682	.639				

Source:Field data.**The test suggests that the difference between the two means is highly significant at 0.01level.

Interpretation: A reference to Table 4.22 reveals that the obtained t value (3.21) was found significant at 0.01 level with degree of freedom 1132, 't' critical value(2.576) being < obtained 't' value. It means that science anxiety of secondary school students vary with respect to their gender with girls being more science anxious. Hence the null hypothesis is rejected.

Table 4.23 depicts the mean and standard deviation scores of students for different dimensions of Science Anxiety Questionnaire (SAQ).

Table 4.23
Mean and Standard Deviation Values of Boys and Girls on Different Dimensions of Science Anxiety Questionnaire

Dimensions of Science Anxiety	Boys (n=532)	Girls (n=602)	Total (n=1134)
Fear of Testing	M=17.60	M=18.5	M=18.08
	sd=3.57	sd=3.82	sd=3.73
Application of Science	M=14.09	M=14.85	M=14.49
	sd=3.19	sd=3.08	sd=3.15
Performance in front of others	M=17.07	M=17.17	M=17.13
	sd=3.49	sd=3.84	sd=3.68
Teachers' Behavior teaching style and teaching environment	M=14.77	M=14.90	M=14.84
	sd=3.04	sd=3.19	sd=3.12
Content Mastery	M=15.84	M=16.29	M=16.08
	sd=3.21	sd=3.44	sd=3.34
Parents' Expectations	M=15.46	M=16.04	M=15.77
	sd=3.69	sd=3.88	sd=3.79

A reference to Table 4.23 suggest that the mean scores girls on all the six dimensions of science anxiety were found to be higher than those of boys. Girls differed slightly from boys especially for dimension Performance in front of others and Teachers' behavior dimension. For all the dimensions the standard deviation for both boys and girls was almost found to be similar.

A further analysis was done using chi square test of association to identify the relationship between gender and students' levels of science anxiety. Science anxiety scores of students ranging from 30-150 were divided into five categories with scores from 30-54 revealing low, 55-79 revealing below moderate, 80-104 revealing moderate, 105-129 revealing above moderate and 111-150 revealing high science anxiety level.Following null hypothesis was proposed for the purpose:

Ho:- *There is no significant association between gender and level of science anxiety.*
The chi-square test of independence was employed to test the null hypothesis.

Table 4.24

χ^2 results for Test of Independence between Gender and Level of Science Anxiety

Group	High SA (130& above)	Above Avg. SA(105-129)	Average SA(80-104)	Below Avg. SA(55-79)	Low SA (30-54)	Total	Level of Significance	Decision on Null Hypothesis
Boys	Obs.2 (exp.2.81)	Obs.133 (exp.161.85)	Obs.317 (exp.296.02)	Obs.73 (exp.62.39)	Obs.7 (exp.8.91)	532	0.01	Rejected
F_o-F_e	-0.81	-28.85	20.98	10.6	-1.91			
Girls	Obs. 4 (exp.3.19)	Obs.212 (exp.183.15)	Obs.314 (exp.334.98)	Obs.60 (exp.70.60)	Obs. 12 (exp.10.09)	602		
F_o-F_e	0.81	28.85	-20.98	-10.6	1.91			
Total	6	345	631	133	19	1134		
$\chi^2 = (F_o-F_e)^2/F_e$		0.23 +0.21+5.14+ 4.54+1.49+1.31+1.80+ 1.59+0.41+0.36=**17.08 *(*df*=4)** χ^2 **=17.08**						

Interpretation of data: The chi-square analysis (Table 4.24) shows that science anxiety is not independent of gender. The obtained chi-square value of 17.08 was found highly significant at 0.01 level at 4 *df*, '$\chi^{2'}$ critical value (13.277) being < obtained χ^2value indicating that there is a significant association between the different levels of science anxiety and gender. Hence the null hypothesis was rejected.

Here, we see that both the 't' test and χ2 analysis reveal that there is a significant difference between the science anxiety of boys and girls.

d) To examine the gender variation in emotional stability amongst the secondary school students.

The research question guided to propose the following null hypotheses:

Ho:*-There is no significant gender difference in secondary school students with respect to their emotional stability.*

Table 4.25 depicts the t-test analysis

Table 4.25

Significance of Difference between Boys and Girls in Relation to their Emotional Stability

Group	Number(N)	Mean	S.D.	SEM	t value	Df	Significance of Difference	Decision on Null Hypothesis
Boys	532	57.97	5.174	0.2243	2.27	1132	S*	Rejected
Girls	602	57.27	5.072	0.2067				

Source: Field data. *The test suggests that the difference between the two means is significant at 0.05 level.

Interpretation: A reference to Table 4.25 reveals that the obtained t value (2.27) was found significant at 0.05 level with degree of freedom 1132, 't' critical value(1.96) being < obtained 't' value. It means that emotional stability of secondary school students vary with respect to their gender with boys being more emotionally stable. Hence the null hypothesis is rejected.

Since there are no dimensions of emotional stability scale the data was not subjected to any further splitting.

A further analysis was done using chi square test of association to identify the relationship between gender and students' levels of emotional stability. Emotional stability scores of students ranging from 30-90 were divided into five categories with scores from 30-50 revealing low, 51-70 revealing moderate and above 70 (71-90) revealing high emotional stability level.

Following null hypothesis was proposed for the purpose:

Ho:- *There is no significant association between gender and level of emotional stability.*
The chi-square test of independence was employed to test the null hypothesis.

Table 4.26
χ^2 results for Test of Independence between Gender and Level of Emotional Stability

	High ES (71-81)	**Above Avg. ES (61-70)**	**Average ES(51-60)**	**Below Avg. ES(41-50)**	**Low ES (30-40)**	**Total**	**Level of Significance**	**Decision onNull Hypothesis**
Boys	Obs.5 (exp.5.16)	Obs.158 (exp.140.74)	Obs.334 (exp.347.16)	Obs.35 (exp.38.94)	Obs.0 (exp.0)	532	0.05	Accepted
F_o-F_e	-0.16	17.26	-13.16	-3.94	0			
Girls	Obs.6 (exp.5.84)	Obs.142 (exp.159.26)	Obs.406 (exp.392.84)	Obs.48 (exp.44.06)	Obs. 0 (exp.0)	602		
F_o-F_e	0.16	-17.26	-13.16	3.94	0			
Total	11	300	740	83	0	1134		
$\chi^2 = (F_o - F_e)^2/F_e$		0.005+ 0.004+ 2.12+1.87+ 0.51+ 0.44+0.39+ 0.35 = 5.69**(*df*=4)** **χ^2=5.69**						

Interpretation of data: The chi-square analysis (Table 4.26) shows that emotional stability is independent of gender. The obtained chi-square value of 5.69 was found insignificant at 0.05 level at 4 *df*, '$\chi^{2'}$ critical value (9.488) being > obtained χ^2value indicating that there is no significant association between the different levels of emotional stability and gender. Hence the null hypothesis was accepted. In totality the sample population was found to be relatively emotionally stable. However the t-test rejects the hypothesis that there is no significant difference on emotional stability of boys and girls at 0.05 level of significance. It describes boys to be more emotionally stable but the mean difference is only of 0.70 points (57.97_{boys}-57.27_{girls}). Since parametric statistics is more robust the minor difference the emotional stability of gender was detected by the t-test which the '$\chi^{2'}$ was not able to detect.

4.2.3Gender Differences in Science and Overall Academic Achievement among Secondary School Students

e) To examine the gender variation in science amongst the secondary school student.

For the given objective the science achievement scores of students were compared with respect to their gender. Following null hypothesis was proposed:

Ho:-*There is no significant gender difference in the secondary school students with respect to science achievement.*
Table 4.27 depicts the t-test analysis.

Table 4.27
Significance of Difference between Boys and Girls in Relation to their Achievement in Science

Group	Number	Mean	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
Boys	532	58.748	14.324	.6210	3.62	1132	S**	Rejected
Girls	602	55.522	15.511	.6322				

Source: Field data, **The test suggests that the difference between the two means is extremely significant at 0.01level.

Interpretation: A reference to Table 4.27 reveals that the obtained t value (3.62) was found significant at 0.01 level with degree of freedom 1132, 't' critical value(2.576) being < obtained 't' value. It means that science achievement of secondary school students vary with respect to their gender. The science achievement of boys is better than girls. Hence the null hypothesis is rejected.

Here the main variable of concern in study is the Student's Science Achievement at secondary level. Students' board results are very decisive in predicting their future choices of streams and profession. Gender is an important factor having its impact on academic achievement of secondary school students in science. This corresponds to similar trends across different societies. In the present study the sample comprises of more girls than boys i.e. 602 girls and 532 boys i.e. 53.086% & 46.91% respectively which almost corresponds to original population of data of secondary school students of Aizawl district (year book 2014-15) which is 51.44% & 48.55% respectively. It means unlike some of the dominant patterns of the country, in Mizoram gender parity has already been achieved, in fact girls' enrolment is greater than that of boys.
If we analyze the description in Table-4.27, there is a significant difference between the science achievement of girls and boys at 0.01 level of significance. The boys with a mean score of 58.75 showed better performance in science compared to girls with a mean score of 55.52. Also the SD (Standard deviation) in the scores of boys is 14.32 compared to 15.51 of girls which mean the scores of boys are less dispersed than that of girls.
The SEM (standard error of the mean) in the science achievement scores for boys is .6210 and for girls is .6322 which means that
For boys

m ± 1SE = 58.75 ± .6210 or 58.129 to 59.371 for the mean (58.75 -.6210 to 58.75+.6210).
For girls
m ± 1SE = 55.52 ± .6322 or 54.89 to 56.15 for the mean (55.52 -.6322 to 55.52+.6322).

f) To examine the gender variation in overall achievement amongst the secondary school student.

It was also tried to study the overall achievement of students in terms of their class X board result and find out whether any significant difference in achievement persists with regard to gender. Following null hypothesis was proposed:

Ho:*-There is no significant difference between boys and girls of the secondary school students with respect to overall achievement.*

Table 4.28 depicts the t-test analysis.

Table 4.28
Significance of Difference between Boys and Girls in Relation to their Overall Academic Achievement

Group	Number	Mean	S.D.	SEM	t value	df	Significance of Difference	Decision on Null Hypothesis
Boys	532	305.92	67.08	2.909	1.878*	1132	NS	Accepted
Girls	602	297.97	74.52	3.037				

Source: Field data, *The test suggests that the difference between the two means is not significant at 0.05level.

Interpretation: A reference to Table 4.28 reveals that the obtained t value (1.878*) was found not significant at 0.05 level with degree of freedom 1132, 't' critical value(1.960) being > obtained 't' value. It means that overall achievement of secondary school students does not vary with respect to their gender. Hence the null hypothesis is accepted.

If we analyze the description in Table 4.28, there is no significant difference between the overall achievement of girls and boys at 0.05 level of significance. The boys showed a mean score of 305.92 and girls showed a mean score of 297.97. Also the SD in the scores of boys is 67.08 compared to 74.52 of girls which mean the scores of boys are less dispersed than that of girls.
The SEM in the overall achievement scores for boys is 2.909 and for girls is 3.037 which means that
For boys
m ± 1SE = 305.92 ± 2.909 or 303.01 to 308.83 for the mean (305.92 – 2.909 to 305.92 +2.909).
For girls
m ± 1SE = 297.97 ± 3.037 or 294.93 to 301.007 for the mean (297.97 -3.037 to 297.97 +3.037).
Although the mean score for boys is higher than that of girls with regard to their overall achievement comprising of all subjects, but there is no significant difference in their achievement.

4.2.4 Gender Differences within High and Low Achievers in Science in relation to ST, SM, SA & ES

g) To find out the gender differences within high and low achievers in science in relation to their Scientific temper, Science motivation, Science anxiety, and Emotional stability.

For the purpose of identifying the high and low achievers in the sample students' science achievement scores were used as grouping variable. The scores were arranged in descending order such that marks were arranged from highest to lowest. The upper 27% of the sample i.e. top 306 sample was identified as the high achievers and similarly the lower 27% of the sample i.e. the bottom 306 sample was identified as the low achievers.

Further within high and low achievers gender comparison was done using t test for the testing of following null hypotheses.

Ho1:*-There is no significant difference in scientific temper of high achievers with respect to gender.*

Ho2:*-There is no significant difference in science motivation of high achievers with respect to gender.*

Ho3:*-There is no significant difference in science anxiety of high achievers with respect to gender.*

Ho4:*-There is no significant difference in emotional stability of high achievers with respect to gender.*

Ho5:*-There is no significant difference in scientific temper of low achievers with respect to gender.*

Ho6:*-There is no significant difference in science motivation of low achievers with respect to gender.*

Ho7:*- There is no significant difference in science anxiety of low achievers with respect to gender.*

Ho8:*- There is no significant difference in emotional stability of low achievers with respect to gender.*

Table 4.29 depicts the t-test analysis

Table 4.29
Significance of Difference between Boys and Girls Within High and Low Achieving Groups of Science in Relation to their Scientific Temper, Science Motivation, Science Anxiety and Emotional Stability

Group	Number	Mean	SD	SEM	T value	df	Significance of Difference	Decision on Null Hypothesis
ST of High Achieving Boys	156	35.32	5.29	.424	0.147	304	NS	***Ho1*** Accepted
ST of High Achieving Girls	150	35.41	4.93	.402				
SM of High Achieving Boys	156	72.70	14.58	1.168	0.491	304	NS	***Ho2*** Accepted
SM of High Achieving Girls	150	71.94	12.27	1.002				
SA of High Achieving Boys	156	95.44	14.70	1.177	2.678	304	S**(0.01)	***Ho3*** Rejected
SA of High Achieving Girls	150	99.76	13.49	1.101				
ES of High Achieving Boys	156	59.74	5.01	0.401	1.973	304	S*(0.05)	***Ho4*** Rejected
ES of High Achieving Girls	150	58.59	5.25	0.429				
ST of Low Achieving Boys	120	29.95	6.34	0.579	0.133	304	NS	***Ho5*** Accepted
ST of Low Achieving Girls	186	30.05	6.88	0.505				
SM of Low Achieving Boys	120	61.26	14.25	1.301	0.931	304	NS	***Ho6*** Accepted
SM of Low Achieving Girls	186	59.69	14.42	1.057				
SA of Low Achieving Boys	120	93.07	13.90	1.269	0.246	304	NS	***Ho7*** Accepted
SA of Low Achieving Girls	186	92.61	17.16	1.258				
ES of Low Achieving Boys	120	55.48	4.26	0.389	1.689	304	NS	***Ho8*** Accepted
ES of Low Achieving Girls	186	56.39	4.80	0.352				

Source: Field data

Interpretation: A reference to Table 4.29 reveals that after the comparison between means on scientific temper of boys and girls within the high achieving groups the obtained t value (0.147) was found not significant at 0.05 level with degree of freedom 304, 't' critical value(1.960) being > obtained 't' value. It means that there is no variation in scientific temper of students within the high achieving groups with respect to their gender. Hence the null hypothesis (***Ho1)*** is accepted.

A similar comparison within the low achieving groups was also performed. Again with reference to Table 4.29 the obtained t value (0.133) was found not significant at 0.05 level with degree of freedom 304, 't' critical value(1.960) being > obtained 't' value. It means that there is no variation in scientific temper of students within the low achieving groups with respect to their gender. Hence the null hypothesis (***Ho5)*** is accepted.

A reference to Table 4.29 reveals that after the comparison between means on science motivation of boys and girls within the high achieving groups the obtained t value (0.491) was found not significant at 0.05 level with degree of freedom 304, 't' critical value(1.960) being > obtained 't' value. It means that there is no variation in science motivation of students within the high achieving groups with respect to their gender. Hence the null hypothesis (***Ho2)*** is accepted.

A similar comparison within the low achieving groups was also performed. Again with reference to Table 4.29 the obtained t value (0.931) was found not significant at 0.05 level with degree of freedom 304, 't' critical value(1.960) being > obtained 't' value. It means that there is no variation in science motivation of students within the low achieving groups with respect to their gender. Hence the null hypothesis (***Ho6)*** is accepted.

A reference to Table 4.29 reveals that after the comparison between means on science anxiety of boys and girls within the high achieving groups the obtained t value (2.678) was found significant at 0.01 level with degree of freedom 304, 't' critical value(2.58) being < obtained 't' value. It means that there is variation in science anxiety levels of students within the high achieving groups with respect to their gender. The level of science anxiety is found higher in girls compared to boys with a mean of 99.76. Hence the null hypothesis (***Ho3)*** is rejected.

A similar comparison within the low achieving groups was also performed. Again with reference to Table 4.29 the obtained t value (0.246) was found not significant at 0.05 level with degree of freedom 304, 't' critical value(1.960) being > obtained 't' value. It means that there is no variation in science anxiety of students within the low achieving groups with respect to their gender. Hence the null hypothesis (***Ho7)*** is accepted.

A reference to Table 4.29 reveals that after the comparison between means on emotional stability of boys and girls within the high achieving groups the obtained t value (1.973) was found significant at 0.05 level with degree of freedom 304, 't' critical value(1.960) being < obtained 't' value. It means that there is variation in emotional stability of students within the high achieving groups with respect to their gender. The mean score of boys on emotional stability is higher than that of girls. Hence the null hypothesis (***Ho4)*** is rejected.

A similar comparison within the low achieving groups was also performed. Again with reference to Table 4.29 the obtained t value (1.689) was found not significant at 0.05 level with degree of freedom 304, 't' critical value(1.960) being > obtained 't' value. It means that there is no variation in emotional stability of students within the low achieving groups with respect to their gender. Hence the null hypothesis (***Ho8)*** is accepted.

4.3 Correlational Analysis

This section deals with relationship analysis between the dependent and independent variables

4.3.1 Relationship between Science Achievement and Selected Affective Variables (ST, SM,SA & ES) of Secondary School Students

a) To find out the relationship between science achievement of secondary school students and selected affective variables (scientific temper, science motivation, science anxiety, and emotional stability).

To understand the relationship between the independent and dependent variables correlation analysis on the variable scores has been performed using Pearson product moment correlation. The scholar also wanted to perform a parallel Spearman's Rank order correlation and compare it with that of Pearson's value.The correlation co-efficient using both the statistical methods is reported in the following Table 4.30. Both the method has given almost similar values.

Table 4.30

Correlation between Achievement in Science (Dependent Variable) and Scientific Temper, Science Motivation, Science Anxiety &Emotional Stability (Independent Variables)

Independent variable	Dependent variable	N	df	Pearson's Correlation Coefficient	Spearman's Correlation Coefficient	Significance level
Scientific Temper(ST)	Science Achievement (Sci.Ach.)	1134	1132	0.338	0.317	Significant**
Science Motivation(SM)		1134	1132	0.314	0.314	Significant**
Science Anxiety(SA)		1134	1132	0.099	0.093	Significant**
Emotional Stability(ES)		1134	1132	0.243	0.248	Significant**

Source: Field data. ** Significant at .01 level

Description on Table 4.30: Here the strength of relationship between the dependent and independent variable is reported using zero order correlation.

Interpretation: By observing the values the correlation coefficient although mild positively related but is found to be significant at .01 level.

i)*Correlation between Achievement in Science (Dependent Variable) and Scientific Temper(independent variable):* The Pearson's and Spearman's Correlation are found 0.338 and 0.317 respectively. If we analyze the strength of relationship it seems that the level of scientific temper of students is positively related to science achievement although at lower magnitude. Out

of all the affective independent variables of investigation Students' Scientific Temper is having maximum strength with Students' Science Achievement. It means greater the level of Scientific Temper, greater is the possibility of better achievement in science.

ii)*Correlation between Achievement in Science (Dependent Variable) and Science Motivation (independent variable):* The Pearson's and Spearman's Correlation are found .314 and .314 respectively. If we analyze the strength of relationship it seems that the level of Science Motivation of students is positively related to science achievement although at lower magnitude. This affective variable is comparable to achievement motivation, a readily studied variable in the past. Research indicate higher the achievement motivation higher the achievement level of the students. As far as Science Motivation is concerned it is affective variable that contribute positively to improve the science achievement of students. Interestingly both the Pearson's and Spearman's Correlation are found to be same.

iii)*Correlation between Achievement in Science (Dependent Variable) and Science Anxiety (independent variable):* The Pearson's and Spearman's Correlation are found .099 and 0.093 respectively. If we analyze the strength of relationship it seems that the level of Science Anxiety of students is positively related to science achievement with the lowest magnitude almost nearing 0.1. Out of all the affective independent variables of investigation Students' Science Anxiety level is having minimum positive strength with Students' Science Achievement. The found value is desirable as a minimum level of anxiety is present even in high achievers. Specifically for Science Anxiety in the population the condition is not alarming but is visible and detectable in the sample which compels the investigator to know the unique impact of the variable on s Students' Science Achievement using further co-relational analysis.

iv)*Correlation between Achievement in Science (Dependent Variable) and Emotional Stability (independent variable):* The Pearson's and Spearman's Correlation are found 0.243 and 0.248 respectively. If we analyze the strength of relationship it seems that the level of Emotional Stability of students is positively related to science achievement at lower magnitude.
The emotional stability of students is a unique affective variable impacting positively to the cognitive level. Here in the current finding suggests that the more emotionally stable students have a positive contributing impact on their Science Achievement.

4.3.2Relationship between Overall Academic Achievement and Selected Affective Variables (ST, SM, SA & ES) of Secondary School Students

b) To find out the relationship between overall academic achievement of secondary school students and selected affective variables (scientific temper, science motivation, science anxiety, and emotional stability).

It was also tried to understand the relationship between the independent variables and dependent variable of overall academic achievement using both Pearson product moment Spearman's Rank order correlation.
The correlation co-efficients using both the statistical methods is reported in the following Table 4.31.

Table 4.31

Correlation between Overall Achievement (Dependent Variable) and Scientific Temper, Science Motivation, Science Anxiety &Emotional Stability (Independent Variables)

Independent variable	Dependent variable	N	Df	Pearson's Correlation Coefficient	Spearman's Correlation Coefficient	Significance level
Scientific Temper(ST)	Overall Achievement (Aca.Ach.)	1134	1132	0.373	0.350	Significant**
Science Motivation(SM)		1134	1132	0.304	0.299	Significant**
Science Anxiety(SA)		1134	1132	0.136	0.114	Significant**
Emotional Stability(ES)		1134	1132	0.271	0.280	Significant**

Source: Field data. ** Significant at .01 level

Description on Table 4.31: Here the strength of relationship between the dependent and independent variable is reported using zero order correlation.
Interpretation: By observing the values the correlation coefficient although mild positively related but is found to be significant at .01 level.

i)*Correlation between Overall Academic Achievement (Dependent Variable) and Scientific Temper(independent variable):* The Pearson's and Spearman's Correlation are found 0.373 and 0.350 respectively. If we analyze the strength of relationship it seems that the level of scientific temper of students is positively related to their overall achievement although at lower magnitude. Out of all the affective independent variables of investigation Students' Scientific Temper is having maximum strength with Students' Overall Achievement. It means greater the level of Scientific Temper, greater is the possibility of higher overall academic achievement.

ii)*Correlation between Overall Academic Achievement (Dependent Variable) and Science Motivation (independent variable):* The Pearson's and Spearman's Correlation are found .304 and .299 respectively. If we analyze the strength of relationship it seems that the level of Science Motivation of students is positively related to their overall achievement although at lower magnitude. As far as Science Motivation is concerned it is affective variable that contribute positively to improve the overall achievement of students.

iii)*Correlation between Overall Academic Achievement(Dependent Variable) and Science Anxiety (independent variable):* The Pearson's and Spearman's Correlation are found 0.136 and 0.114 respectively. If we analyze the strength of relationship it seems that the level of Science Anxiety of students is positively related to their overall achievement with the lowest magnitude out of all the affective variables. Out of all the affective independent variables of investigation Students' Science Anxiety level is having minimum positive strength with Students' Overall Academic Achievement. The found value is desirable as a minimum level of anxiety is present even in high achievers.

iv)*Correlation between Overall Academic Achievement(Dependent Variable) and Emotional Stability (independent variable):* The Pearson's and Spearman's Correlation are found 0.271 and 0.280 respectively. If we analyze the strength of relationship it seems that the level of Emotional Stability of students is positively related to overall academic achievement at lower magnitude.

4.3.3Net and Collective Impact of Affective Variables (ST, SM, SA & ES) on Science Achievement of Secondary School Students

c) To measure the net and collective impact of scientific temper, science motivation, science anxiety, and emotional stability on science achievement of secondary school students.

In order to further understand the relationship between the dependent and independent variables partial, semi partial and multiple correlations were computed by the investigator.

As stated by Garrett, "Partial and multiple correlations represent an important extension of the theory and techniques of simple or 2-variable linear correlation to problems which involve three or more variables. The correlation between two variables is sometimes misleading and may be erroneous if there is little or no correlation between variables other than that brought about by their common dependence upon a third variable (or several variables)."

This suggests that in order to understand the real relationship between two variables of concern the effect of other independent or confounding variables must be nullified. Partial correlation is an interesting technique to do so and it can involve as many variables. Here the effect of one and/or two and/or three and so on, variables is made constant so that unique strength between any two variables can be measured. In the present study there are four independent affective variables in the study whose effect is measured on the main dependent variable, Science Achievement. So one by one the unique relationship of each of the IVs with the DV is studied. Correspondingly the first, second and third order correlation coefficients were computed along with the semi partial correlation at third order level in which the effect of control variables is removed only from independent variable and not from dependent variable. These values are shown in following Table 4.32.

Table 4.32
Partial and Semi Partial Correlation in Relation to Science Achievement

Variables	Zero order	First order Partial correlation	Second order Partial correlation	Third order Partial correlation	Part/Semi-partial Correlation(Partial out the effect of controlled variable from IV not from DV)
Science Achievement(DV) 1	r12	r12.3	r12.34	r12.345	r1(2.345)
	.338	.247	.229	.202	.187
Scientific Temper(IV) 2	r13	r13.2	r13.24	r13.245	r1(3.245)
	.314	.211	.222	.197	.182
Science Motivation(IV)3	r14	r14.2	r14.23	r14.235	r1(4.235)
	.099	.055	.089	.107	.097
Science Anxiety(IV) 4	r15	r15.2	r15.23	r15.234	r1(5.234)
	.243	.178	.146	.157	.144
Emotional Stability(IV) 5					

Source: Field data

Description of Table 4.32: For simple representation the DV, Sc. Ach. is labeled as 1 and IVs ST, SM,SA & ES are respectively labeled 2, 3, 4, & 5. The correlation coefficient is 'r' with suffix indicative of two variables of focus in bivariant analysis. The number after '.' (dot) is indicative of variable(s) partialed out which can be 1, 2 or 3 variables respectively for 1st , 2nd and 3rd order partial correlation.

Interpretation: It is observed that as the effect of one or more variable is partialed out the strength of relationship between dependent and independent variable of concern is getting decreased suggesting then net relationship between any affective variable with science achievement always tends to decrease. It means all the confounding affective variables also contribute positively to the zero order relationship. The green coloured cells in the Table-4.28 are indicative of decrease in correlation

However, exceptionally the correlation is increasing in few cases. The yellow coloured cells are indicative of increase in correlation as the order of correlation increases.

To understand the decrease in strength a following description is provided:

If we square the zero order correlation i.e. r12 correlation (.338) as .338x.338 =0.114244,i.e 11.42 % of variance in the criterion or dependent variable, Science achievement is predicted by scientific temper without partialing out the effect of any other confounding affective variables.

If we square the partial correlation i.e. partial correlation r12.345(.202) as .202 x .202=0.040804,i.e 4.08 % of variance in the criterion or dependent variable, Science achievement is predicted by scientific temper partialing out the effect of variables 3,4,5

If we square the semi-partial correlation i.e. r1(2.345) correlation as .187 i.e. .187 x .187=0.034969,i.e 3.49 % of variance in the criterion or dependent variable, Science achievement is predicted by scientific temper partialing out the effect of variables 3,4,5 on scientific temper and not on Science achievement.

Thus we observe by this example that as the order of correlation is increasing the strength of the two variables of concern at a time is decreasing.

Especially in case of understanding the unique or net relationship between scientific temper and science achievement of students a decreasing trend in correlation strength is observed as the order of correlation is increasing. Although Science anxiety is relatively said to be negative affective variable, but it is found in the present data that even after partialing out the effect of science anxiety the correlation strength still decreases. This suggests that somehow the affect of science anxiety contribute positively to the relationship of scientific temper and science achievement.

However, if we see the yellow coloured cells exceptionally, the correlation is increasing. There are four such instances where the decreasing correlation is suddenly increasing although in a very less magnitude. This may be happening especially when effect of science anxiety is being patialed out which means may be science anxiety was negatively contributing to correlation and when its effect is partialed out the strength suddenly increases(for yellow cells only)

All the four instances are explained in following way:

To interpret meaning out of this effect it can be said that the zero order correlation of science motivation and science achievement initially decreased on partialing out the effect of scientific temper (.314 to .211) and suddenly increased (.211to .222) when the effect of science anxiety was partialed out. This may be due to the fact scientific temper was positively contributing and science anxiety might be negatively contributing in explaining the strength of relationship between science motivation and science achievement.

Similarly, the zero order correlation of science anxiety and science achievement initially decreased on partialing out the effect of scientific temper (.099 to .055) and suddenly increased (.055 to .089) when the effect of science motivation was partialed out. It further increases (.089 to.107) if the effect of all confounding variables is removed. This may be due to the fact scientific temper was positively contributing and science motivation and emotional stability might be negatively contributing in explaining the strength of relationship between science anxiety and science achievement. It may be concluded that the trait of scientific temper is not interfering with science anxiety possession in the population but it may be that students high on science motivation and high emotional stability may not be equally science anxious. Since the increase and decrease in very less magnitude the provided explanation may not be adequate to understand the relationship between science anxiety and science achievement of students.

Finally, another instance where there is sudden increase in the correlation strength is observed is that of relationship between emotional stability and science achievement of students. It is observed that the third order correlation strength increases from initial second order correlation (.146 to .157) when the effect of science anxiety is partialed out. This again indicates that may be science anxiety is contributing negatively to explain the relationship of emotional stability and science achievement whereas affective variables of scientific temper and science motivation contribute positively in explaining the same relationship.

However this increase and decrease of correlation coefficient is not of high magnitude which indicates that zero order correlation are not that misleading in this sample population.

This also indicates that the collective impact of all IVs on DV can give a meaningful picture to the relationship between the variables. Multiple correlation technique enables us to deduce the collective contribution of all independent variables of study on the dependent variable.
Following Table 4.33 summarizes the value of Multiple R.

Table 4.33
Output Summary of Multiple Correlation of Affective Predictor Variables (IVs) on the Prediction of Science Achievement (DV) of Secondary School Students

Dependent Variable (Science Achievement)	Independent Variable (ST,SM,SA,ES)	Independent Variable (ST,SM,ES)
Multiple R	0.426	0.414
R Square	0.181	0.172
Adjusted R Square	0.178	0.169
Standard Error	13.64	13.71
No. of Observations	1134	1134

Source: Field data

Description of Table 4.33: The table shows the values of Multiple R, R Square, Adjusted R and Standard Error.

Interpretation: R Square = 0.181 which means approximately 18% of the variance in the predicted dependent variable (science achievement) is determined by the collective influence of all four independent variables.
Since all the variables of investigation are primarily from affective domain the amount of direct contribution to achievement in science is always not visible. But affect can definitely create favorable conditions for cognition to happen. This has been very well documented in the available literature.
18 % collective contribution of ST, SM, SA & ES is although a very less contribution but not a non-meaningful contribution. Out of all IVs Science Anxiety holds a relatively negative impact on science achievement hence the investigator tried to measure the multiple R excluding SA.
It is interesting to note if the collective effect of ST, SM and ES is seen on Sc. Ach. excluding science anxiety(SA) the correlation decreases to 0.414 from 0.425 (Table 4.33), the R Square value becomes 0.171 and Adjusted R becomes 0.169 with a similar standard error of estimate 13.71. It means some minimal SA levels also contributed to science achievement as assumed by the investigator.

4.3.4 Net and Collective Impact of Affective Variables (ST, SM, SA & ES) on Overall Academic Achievement of Secondary School Students

d) To measure the net and collective impact of scientific temper, science motivation, science anxiety, and emotional stability on overall academic achievement of secondary school students.

A similar analysis was performed in order to further understand the relationship between the dependent variable of students' overall academic achievement and independent variables by finding the partial, semi partial and multiple correlations.

One by one the first, second and third order correlation coefficients were computed along with the semi partial correlation at third order level in which the effect of control variables is removed only from independent variable and not from dependent variable. These values are shown in following Table 4.34

Table 4.34
Partial and Semi Partial Correlation in Relation to Overall Academic Achievement

Variables	**Zero order**	**First order Partial correlation**	**Second order Partial correlation**	**Third order Partial correlation**	**Part/Semi-partial Correlation(Partial out the effect of controlled variable from IV not from DV)**
Overall Achievement(DV) 1	r12	r12.3	r12.34	r12.345	r1(2.345)
	.373	.291	.268	.238	.218
Scientific Temper(IV) 2	r13	r13.2	r13.24	r13.245	r1(3.245)
	.304	.186	.203	.174	.157
Science Motivation(IV)3	r14	r14.2	r14.23	r14.235	r1(4.235)
	.136	.091	.122	.144	.129
Science Anxiety(IV) 4	r15	r15.2	r15.23	r15.234	r1(5.234)
	.271	.202	.174	.190	.172
Emotional Stability(IV) 5					

Source: Field data

Description of Table 4.34: For simple representation the DV, Acd. Ach.is labeled as 1 and IVs ST, SM,SA & ES are respectively labeled 2, 3, 4, & 5. The correlation coefficient is 'r' with suffix indicative of two variables of focus in bivariant analysis. The number after '.' (dot) is indicative of variable(s) partialed out which can be 1, 2 or 3 variables respectively for 1st , 2nd and 3rd order partial correlation.

Interpretation: It is observed that as the effect of one or more variable is partialed out the strength of relationship between dependent and independent variable of concern is getting decreased suggesting then net relationship between any affective variable with academic achievement always tends to decrease. It means all the confounding affective variables also contribute positively to the zero order relationship. The green coloured cells in the Table-4.28 are indicative of decrease in correlation

However, exceptionally the correlation is increasing in few cases. The yellow coloured cells are indicative of increase in correlation as the order of correlation increases. This pattern is similar to the correlational pattern observed between dependent variable of science achievement and independent affective variables.

Here also the net relationship between scientific temper and overall academic achievement of students is following a decreasing trend in correlation strength as the order of correlation is increasing. It is found in the present data that even after partialing out the effect of science anxiety the correlation strength decreases which suggest perhaps here science anxiety is not playing negative role towards the science achievement. This suggests that somehow the affect of science anxiety contribute positively to the relationship of scientific temper and overall achievement.

However, if we see the yellow coloured cells exceptionally, the correlation is increasing. This pattern is exactly similar to the pattern observed between dependent variable of science achievement and independent affective variables.

There are four such instances where the decreasing correlation suddenly increasing although in a very less magnitude. This may be happening especially when effect of science anxiety is being patialed out which means may be science anxiety was negatively contributing to correlation and when its effect is partialed out the strength suddenly increases.

The four instances are explained in the following way:

To interpret meaning out of this effect it can be said that the zero order correlation of science motivation and overall achievement initially decreased on partialing out the effect of scientific temper (.304 to .186) and suddenly increased (.186 to .203) when the effect of science anxiety was partialed out. This may be due to the fact scientific temper was positively contributing and science anxiety might be negatively contributing in explaining the strength of relationship between science motivation and science achievement.

Similarly, the zero order correlation of science anxiety and overall achievement initially decreased on partialing out the effect of scientific temper (.136 to .091) and suddenly increased (.091 to .122) when the effect of science motivation was partialed out. It further increases (.122 to .144) if the effect of all confounding variables is removed. This may be due to the fact scientific temper was positively contributing and science motivation and emotional stability might be negatively contributing in explaining the strength of relationship between science anxiety and overall achievement. It may be concluded that the trait of scientific temper is not interfering with science anxiety possession in the population but it may be that students high on science motivation and high emotional stability may not be equally science anxious. Since the increase and decrease in very less magnitude the provided explanation may not be adequate to understand the relationship between science anxiety and overall achievement of students.

Finally, another instance where there is sudden increase in the correlation strength is observed is that of relationship between emotional stability and overall achievement of students. It is observed that the third order correlation strength increases from initial second order correlation (.174 to .190) when the effect of science anxiety is partialed out. This again indicates that may be science anxiety is contributing negatively to explain the relationship of emotional stability and overall achievement whereas affective variables of scientific temper and science motivation contribute positively in explaining the same relationship.

It was tried to see how all the studied affective variables i.e. scientific temper, science motivation, science anxiety and emotional stability collective contributes to overall achievement. Table 4.35 depicts the multiple R values.

Table 4.35
Output Summary of Multiple Correlation of Affective Predictor Variables (IVs) on the Prediction of Overall Achievement (DV) of Secondary School Students

Dependent Variable (Overall Achievement)	Independent Variable (ST,SM,SA,ES)	Independent Variable (ST,SM,ES)
Multiple R	0.459	0.440
R Square	0.211	0.194
Adjusted R Square	0.208	0.192
Standard Error	63.37	64.01
No. of Observations	1134	1134

Source: Field data

Description of Table 4.35: The table shows the values of Multiple R, R Square, Adjusted R and Standard Error.

Interpretation: R Square = 0 .211 which means approximately 21% of the variance in the predicted dependent variable (Overall achievement) is determined by the collective influence of all four independent variables. 21 % collective contribution of ST, SM, SA& ES is a higher contribution to the overall achievement of students' achievement in comparison to 18% contribution to science achievement. The probable reason for this increase in the strength of correlation is the role of subjects related to humanities which involves the learners' affect more in comparison to science exclusively. Also, if a similar analysis is performed with affective variables towards mathematics achievement is done it is very much possible that the correlation is still very less. This suggest that discipline of science and mathematics are not exploited much to involve learners' affect in comparison to humanities like languages and social sciences where the affective component is very much an inbuilt component. It can be concluded that affective domain of learner predicts the academic achievement of the learners to an extent that it could be directly visualized but still it has indirect influence on their academic achievement. Although the collective impact of all four affective variables is very less (21%) but nevertheless it is not a non meaningful contribution. Out of all IVs Science Anxiety holds a relatively negative impact on science achievement hence the investigator tried to measure the multiple R excluding SA. It is interesting to note if the collective effect of ST, SM and ES is seen on Sc. Ach. excluding science anxiety(SA) the correlation decreases to 0.459 from 0.450 (Table-4.35), the R Square value becomes 0.194 and Adjusted R becomes 0.192 with a similar standard error of estimate 64.01. It means some minimal Science anxiety levels also contributed to overall achievement as assumed by the investigator. Thus it was found that science anxiety had contributed positively both in case of science and overall achievement of students.

4.4 Situational Analysis: Field Observations

This analysis relates to the situational observationsmade by the researcher in relation to classroom and school variables in context of science teaching learning practices. Since the researcher chose to keep the approach of the study mixed an attempt was made to employ both quantitative and qualitative techniques to gather data. However, the majority of finding of study relate to inferential analysis using appropriate statistical technique, some of the finding was gathered through some of the field observations in order to fulfill the research objective of the assessment of the situational classroom related variables in context of science teaching learning practices. The findings are summarized in this section.

In the course of research, the researcher visited 36 schools in total in different parts of Aizawl district. Through the school situational observations it become evident that there is a dearth of good science education and laboratory culture is very much in its infancy. Debarring few exceptional missionary schools, the practice of going to laboratory at secondary level is totally absent. While interacting with teachers of school it was discovered that the prescribed practical manual for class IX and X is not very much discussed in the classes and the question answers are made to be learnt by the students through rote learning in order to pass the exams. Most of the schools of all types (govt. / semi govt. / private) practice the use of guide for preparing students. Such practices in science teaching and learning are not in harmony with the spirit of science education. The researcher also discovered that most schools do not teach the students how to handle a light microscope. This was concluded on the basis of the responses of students of class X towards an item in a scale that asked them that how do they feel while handling a microscope where they had to choose between 5 points ranging from very tensed, tensed , neutral, relaxed and very relaxed. Upon the analysis of data it was found most of the students ticked neutral as they were not aware of the feeling associated with handling of microscope. Either they have never handled the microscope or they have got the chance to just see it once. Proper handling and use of microscope is prescribed as a laboratory content in class X practical manual which students were very much aware of but it was taught to them only verbally in most of the schools. This conclusion was made on the basis of doubt raised by many students against this item.
The student's perception towards the science subject is also in a confused shape as they don't want to opt it for higher education. They don't find it understandable in comparison to other subjects. However, a similar perception is also found for mathematics. This observation holds a direct linkage to teaching-learning practices of science subject at secondary level. The state requires a huge brigade of trained science teachers to cater to the demand of good science teachers at elementary and secondary level. On further discussions with some teachers the researcher was informed that after the state has implemented the 'no detention policy' during the elementary years of children, teachers are bound to make science teaching very dilute for students in absence of which students could not be promoted smoothly to the next class. Due to the application of 'no detention policy', students are not given enough training for processes skills of sciences during the elementary stages and are given promotion without testing of these

skills. As a result of this upon entering first year of secondary schooling many students face detention as they are not able to cope up with the sudden change of evaluative criterion. They were never exposed to science learning and practices and hence they don't take interest in such subject which seems quiet alien to them. It was observed that in majority of government schools there is a heavy detention in class IX, as a result of which many student do not reach class X. This was observed in one of the government schools which had two sections of class IX and no class X for a block year as none of students in class IX could be promoted to next class. There is also a trend in students to not appear in board exams when they are finding themselves not ready for board exams. It is a question to ponder who is responsible for making changes in the prescribed standards of science curriculum, the teachers or the administrators. Some of the headmasters and principals shared their concern of students' failure and they consider that high detention at secondary levels is mainly contributed by science and mathematics performance of students.

The medium of instruction for science teaching is mother tongue till elementary stages and from secondary classes it is bilingual and students have to answer the subject questions in English at secondary level. There is lack of science text book in mother tongue which is another big reason of students' poor performance in the subject. Lack of uniformity of medium is a big problem in the state. Moreover, when the researcher travelled to remote distant areas of Aizawl district the conditions became far more serious pertaining to fact that these places have very less exposure to revolutions of science and science is just a subject to be covered for qualifying the examination of a certain stage.

Keeping aside all the situational research setting what was found in contrast and unique within the students is their high level of scientific temper and science motivation. They have a very important prerequisite to make meaningful science learning to happen. This relates to individual factor that can contribute positively to science achievement. Students' achievement is very much controlled by school and outside school factors apart from individual factor. The high level of science anxiety and moderate level of emotional stability of students suggest that environment both at school and home may not be so favorable that enables them to combat their fear associated with science. Through unstructured interviews with students and their science teachers some insight was gained pertaining to this specific fear. It was found that the performance levels in science seem to be evaluated mainly on one's ability to write well in board exams. Students fear science because they identified its' nature as a very dry and abstract. There was dearth of practical demonstrations in classes and most students fail to link the subject with their lives. The parameters of judging a students' performance in science are very rudimentary emphasizing more on memorization and non-rational thinking. As far as teachers are concerned their focus was mainly to get good passing percentage in their respective science classes as the board results have been consistently projecting students' underperformance in science. Students are made to learn science only through the text available in the huge books and science teaching has been and is still oral in character. The fault for this failure lies more with the system than with the teachers and students. Students are found to be very comfortable with their science teachers' personality,

behavior, teaching style which we tried to measure as one dimension. As evidenced through the sample both students and teachers felt the constant threat to achieve better in science and those who achieved higher were found to be more science anxious. However, science anxiety below threshold level is quite natural and acceptable for good performance in science.

Culture of study camps for secondary schools was observed by the researcher mainly in the private schools which was a good practice for collaborative and peer learning. This is one of the unique features of state education and is very much liked by the students. One special feature about Mizo students are that they are very much attached to their teachers and they act as a good human resource in sharing of responsibilities of school functioning. This team working culture of Mizo population should be utilized in science teaching-learning situations like organization of science fairs, exhibitions, clubs, olympiads, book-stalls with the efforts of all the stakeholders of education. This culture needs to be initiated right from the elementary years of students so that they are having a feel of being in the character of a scientists, investigator and researcher. The researcher feels that the required traits for understanding, feeling and doing science are very much in-built in Mizo population owing to their immediate proximity with the nature which is part of their identity, both traditionally and environmentally. The local folklores, tacit knowledge, traditional ecological knowledge is part of their cultural inheritance which can be used in science classroom when dealing with natural world.

4.5 Logical Analysis: Complementarities between ST & NOS

Finally an attempt was made to identify the complementarities between scientific temper and nature of science (NOS) through logical analysis. The researcher believes that there are some inter-linkages between the two construct. The available review of literature suggests that notion of NOS is very mis-represented in school curriculum and is resulting in misunderstanding related to the discipline of science. Bell (2008) suggests current reforms in science education emphasize teaching science for all, with the ultimate goal of developing scientific literacy. Many science educationists believe that the correct understanding of NOS is key to develop scientific literacy within one and all. McComas, Almazroa &Clough(1998) argued that a pragmatic consensus exists regarding NOS topics most important for a scientifically literate society and thus NOS instruction should be taking most prominent role in science curriculum. The construct of scientific temper conceptualizes the behavioral outlook of a scientifically literate person. Like every discipline science also has three important component viz. Knowledge, Attitude and Skills. There are gaps between the scientific knowledge, scientific attitude or temper and actions in science which are respectively coming under the cognitive, affective and conative domain of learning. Cognition is the process of thinking; Affection is association with feelings and emotions, Conation is vectored energy, i.e.: personal energy that has direction and magnitude (Atman, 1987). There is a possibility of removing the existing gaps between the three domains of science through the proper understanding of nature of science. Bell (2008) suggested to link process skill with NOS for better deciphering of the notion of NOS within students. Science process skills are the actions performed in the science classrooms, are basically translation of scientific knowledge into action through a particular methodology. They are conative in nature as

they are expressed through psycho-motor behaviour and are having their roots in cognition and affect. In toto it can be said there is a real need to bridge the gap existing between scientific knowledge and scientific behaviour. The later is a byproduct of affect and actions which are not given direct considerations in science curriculum. It is assumed that a proper acquaintance to NOS seems to serve the purpose of bridging this gap. There has been historically an advocacy for students' understanding of NOS since the beginning of 20th century (McComas, Almazroa & Clough,1998) but sadly very little has been achieved from the point of science curriculum.

The real Nature of Science (NOS) is never understood especially in philosophical perspective in traditional school science. It is the most abstract domain of science education and hence most little dealt. NOS is an unfamiliar and alien domain in Indian scenario. NOS is a multifaceted concept that including the aspects of history, sociology and philosophy of science and has been defined variously as science epistemology, the characteristic of scientific knowledge and science as a way of knowing (Bell, 2008). Often it is misunderstood by the teachers and mis-communicated to the students leading to conceptual stigmas. This domain of science is poorly addressed in majority of curricular materials, and when it is addressed it is misrepresented (Bell, 2008). NOS acquaints student with kind of knowledge generated by the scientific community and characterize its generalizations and limitations both. The very basic NOS is that science cannot provide complete answer to all questions/problems (Eastwell, 2001). But often societies hold just an opposite assumption and have far-fetching expectations from science. Another common assumption about science is that everything which is imagined scientifically should find an experimental explanation in order to be part of scientific knowledge. But there are instances where only through imagination many probable solutions for a given problem were sought by a scientist, which was found to be absolutely valid when tested by someone else. A popular myth about NOS is that there is 'a universal scientific method' every time followed by scientists to derive scientific knowledge (Eastwell,2001; Bell,2008). This belief needs to be rectified. Whereas scientific method is most followed method in deriving scientific knowledge, there are still some parallel means like experience, imagination and intuition that may also work in order to reach certain conclusions.

The whole scientific enterprise is based on notion of 'tentativeness' which states that nothing in science can be treated as constant static truth rather it is dynamic truth. Scientific knowledge is a filtered authentic and stable piece of knowledge which is checked for its validity and reliability in multiple experimental settings. Replication of experimental setting is nothing but filtering the facts and nearing the truth. The degree of authenticity of this knowledge increases every time it is verified through truth filters. Scientific knowledge is some time subjective but its subjective nature can be translated to objectivity by perseverance i.e. through repeated trials. Science seeks subjective clarification although it is objectively conceived. Science is not a solitary pursuit (Eastwell, 2001) rather a collective and cooperative endeavor and a valid scientific explanation may not be possible in a standalone platform. Science is value free but technology which is a companion to science is value laden. It is associated with some goodness or badness about it; and hence technology is not science (Wolpert, 2002). Technology makes scientific principles,

theories, and laws workable and usable but science is far more than a technological enterprise. Perhaps in Indian educational setting treating science as technology is the biggest misconception about the nature of science held by students and teachers. NOS is not part of science curriculum in our country which leads to inadequate understanding about science within the school students. Students fail to utilize the scientific knowledge in their own lives because they are never exposed to the notion of NOS. The problem emerges because of lack of harmony in between scientific methods and process skills in science teaching. The science laboratories are often overloaded with miniature practical replicas of experiments having no time for discussing the kind of process skills required for doing science. This creates lot of confusion and tension in the minds of young learner who might find learning and doing science bit abstract. Students are taught what to explain but not how to explain, they are taught how to reach a particular conclusion through an observation but not what they can infer from observations and its background; students are taught about forward approach of experimenting and concluding and not much about backward approach of designing a new experiment based on permutations and combinations of available facts. This is how students are introduced to the NOS, at least till their secondary level of schooling in our country. This characterizes science as being abstract, hostile, difficult, serious, not fit for all, which is not the real nature of science. Bell (2008) highlighted the importance of science process skills in order to understand the nature of science. Science process skills can be taught to students right from their elementary science lessons, thus can become a potential tool in teaching the NOS. Doing science at any stage of schooling has a direct bearing to basic process skills like observing, measuring, classifying, inferring, communicating, prediction and higher order integrated process skills like hypothesizing, investigating, controlling, and experimentation. It thus has an indirect linkage with NOS. This leads to a thought that non-misinterpreted knowledge of NOS enables a student of science and even the non-science students to rightly relate scientific knowledge with their lives. The task of the teacher is to provide clarity against some popular myth about NOS. Students should be well aware about real nature of science, in absence of which they might not be able to understand the real essence of doing science.

The guiding question, that what is the relationship between being scientifically tempered and understanding the nature of science (NOS)? An analysis of characteristics of scientific temper and nature of science suggest that there is some overlapping characterization. It is explained as follows:

It is believed that students ‘understanding of science’ as a ‘way of knowing’ is absolutely necessary if informed decisions are to be made regarding the scientifically based personal and societal issues that increasingly confront them; such decisions necessarily involve careful evaluation of scientific claims by discerning connections among evidence, inferences, and conclusions(Zeidler et.al., 2004)

A popular myth about NOS states that everything can be proved using scientific method alone. Scientific method is an amalgamation of inductive and deductive method. There is debate in

scientific community over the superiority of one over other. It is just like egg and chicken puzzle asking which came first. However, there is no fixed method but 'trial and error' method is the heart of any scientific expedition. Even in primitive times the discovery of fire or the invention of wheel was an outcome of trial and error. In both inductive and deductive methods there is commonality of evidence. 'Evidence' is observable by our senses and inferable through logic. Scientific temper can be equated to application of the scientific method based on logic and evidence (Palampur declaration, 2011). A scientifically tempered person therefore looks for evidences to judge any situation. He/she tries to evaluate things, situations and circumstances in the light of evidence. The history of science reveals both evolutionary and revolutionary changes where with new evidence and interpretation, old ideas are replaced or supplemented by others (National Science Teachers Association, USA, 2000). A scientifically tempered person similarly revolutionary in his ideology and is more open to a change. He/she resorts to trial and error frequently before coming to a conclusion.

A second point of overlap is provided by finding an answer to the question that should we rely on facts or methodology of doing science. NOS advocate the importance of process over content. Mere content which enables us to answer 'what' and not 'how' are misleading for students of science. According to Dewey (1916) understanding scientific method is more important than acquisition of scientific knowledge provides a support system to any person in taking scientific decisions. A scientifically tempered person tests the factual knowledge for its validity and does not simply believe on any propaganda or statement. He/she applies the process of sciences to derive meaningful conclusions. The open mindedness of a scientifically tempered person guides him/ her to perceive reality keeping space for required adjustments as and when required for accommodating whole truth than partial truths.

Thirdly, it is felt that proper analysis of contexts are very important in any decision making process. Seeing things through the lens of context is an outcome of post-modern thought process which asks whether science is interdependent with or independent of cultural context. For e.g. there are instances in the history of science when some scientists never gave up their faith in a particular theory which they claimed to be true and tried to adhere to it. Such claims were rewarded much later for their truth, sometime even posthumously. Our immediate surroundings, contexts, frame of references are our first teachers. Our contexts shades our imagination and give rise to our ways of thinking. There is nothing wrong in being contextualized and the real NOS appreciate its significance. In recent times the local ecological knowledge and the tacit knowledge has been acknowledged for its benefits which is nothing but contextualized knowledge. Lack of rigidity in the attitude helps a scientifically tempered person to be more adaptive to changing times. He/she sees things in light of contexts and rely on holistic inferences and not single observation.

Finally, there is a central question, whether science is all about providing ideas which are workable or science is just a knowledge expedition, whether it is works or not is a matter outside its purview? Wolpert (2002) raised a similar question, whether scientists are for application of

science? He answered this question by saying, this is neither possible nor should be expected from scientists. Scientists just search truth and in course of doing so some time through serendipity, or by curiosity some unexpected outcomes take place. A scientist cannot predict the future outcome of his discovery or invention. The real problem comes when a scientific finding is applied in public through technology, which inherently comes with ethical issues (Wolpert, 2002). The real nature of science is honest inquiry where a scientist is not held responsible for the unpredictable consequence of a scientific finding. The very nature of science is that it is not possible to predict what will be discovered or how these discoveries could be applied the most apt example being that of cloning (Wolpert, 2002).Science is neither good nor bad but it is its application which makes it good or bad. Man is a moral being and it is his decision making that decides the course of science. Wolpert (1992) defines 'openness' as one of the most characteristic features of science, along with allowance for controversy and public access to knowledge. Technology, by contrast, he presents as a style of thought that promotes secrecy and thrives in recipes and opaque (pre-scientific) procedures. Thus issue of morality and ethics is involved with every application of science made possible through the technological enterprise. Technology on one hand depends on science and on the other hand paves the path for future scientific endeavor. While science and technology do impact each other, basic scientific research is not directly concerned with practical outcomes, but rather with gaining an understanding of the natural world for its own sake (National Science Teachers Association, USA, 2000). Hence reliable scientific knowledge is value-free and has no moral or ethical concern. In light of this conception the nature of science is very unpredictable and a scientifically tempered person knows how to judge a scientific discovery or invention in the light of morality. For e.g. a person with such temper will surely choose to technologies which are environmental friendly such as biodegradable, pollution free, natural, cost effective and efficient. A very apt scenario of ignorance of scientific temper is presented through the plot of Gulf war where massive resources of oil fields in a gulf nation were destroyed by another nation just to win a battle, which was fought keeping the interests of total world population at stake. Natural resources are commonly shared inheritance of all the human beings in terms of economic equality, but sadly very few nations own the maximum resources of the world. There is a fine line difference between being intelligent and wise. This is very well explained by Sir Bertrand Russell, a great philosopher, mathematician, scientist and social reformer,

"We are in the middle of a race between human skills as to means and human folly as to ends…….Unless men increase in wisdom as much as in knowledge, increase of knowledge will be increase in sorrow."

A person with scientific temper knows that being realistic, providing unbiased reality, with no hidden agenda or component of secrecy is real NOS. He/she knows that sometime all the answers cannot be provided by instrumental approach of science. Scientific temper in people enables them to suspend judgment through accuracy in thought and action. They need to know the situation through an independent unbiased perspective and then judge it. Being unbiased is a

key trait of NOS and scientific temper both. The trait of scientific tempered highlights the natural tendencies of children but as they grow, the degree of its effectiveness tends to decrease owing to constant molding through school science which somehow has been the main vehicle to propagate myths about NOS. As a result students fail to distinguish between science and technology, they believe that there is one universal scientific method which is followed by all scientists and that the scientific truths are unchangeable. Knowledge of NOS enables a person to distinguish between science and technology which in turn helps him to take informed decisions on the acceptance or rejection of a technology. If we as science educators wish to cultivate future citizens and leaders who care, serve the community, and provide leadership for new generations, then we have a moral imperative to delve into the realm of virtue, character, and moral development (Zeidler et.al, 2004). There is a guiding value system in built in nature of science that helps citizens to take informed decisions. What is required out of the process of schooling that children should be introduced to real nature of science and safeguard them from popular myths held about NOS.

Thus it can be concluded that it will be a mistake to call an age a scientific age just on the basis of the accumulated mass of scientific knowledge. An age can be called as scientific when the problem of society can be faced and handled by men with scientific temper (Jahagirdar). Through its emancipatory nature, science liberates us from the bondages of superstitions, bridges the gap between different strata of society, and has the potential to solve all the problems of mankind. In contrast, the same science can be mishandled and made oppressive through politicization and power play. The benefits of science like modern medicine, means of comfort are not equally accessible to all. It leads to new plot of disparity. This plot is very nicely narrated in the words of Nehru, “To-day, in the world of politics and economics there is a search for power and yet when power is attained much else of value has gone. Political trickery and intrigue take the place of idealism, and cowardice and selfishness takes the place of disinterested courage.” (1946, pp. 560). The main question of concern in 21st century is how much scientifically tempered we are? Are we prepared to choose between right and wrong, just on the basis of our training in science or we need something more than that?

It is very evident that real nature of science enables a science student to better learning experiences in science. Also it is through knowledge of NOS students are able to identify themselves with science in holistic perspective through the lens of history, sociology and philosophy of science. They find it more convictional and adaptable in their daily affairs. A scientifically tempered person possesses a mind-set that uses scientific method as a way of problem solving in his/her day to day life. If he/she knows the NOS well, he or she can do more informed decision making. Such people are more rational in their approach. Societies preaching the real nature of science through the process of schooling seem to be more scientifically tempered in their outlook.

CHAPTER-5
FINDINGS AND CONCLUSION OF THE STUDY

FINDINGS AND CONCLUSION OF THE STUDY

5.0 Introduction

The analysis and interpretation of data led to some major findings which further led to drawing of final conclusions. This chapter chalks down all the major findings in the light of objectives of the studies and testing of null hypothesis as stated in the previous chapter. Following are the major findings of the present study:

5.1 Major Findings:

5.1.1 Finding relating to Descriptive Analysis

It was found that both the independent variables and dependent variables were within the limits of ±1 values for both kurtosis and skewness. Therefore all the independent affective variables i.e. scientific temper, science motivation, science anxiety, emotional stability and the dependent variables of science achievement and overall achievement are more or less normally distributed with variations in their skewness and kurtosis values. Following is the description of all the variables of the present study

5.1.1.1 Findings related to Measures of Central Tendency, Dispersion and Shape of distribution

i. The range of score obtained on the scientific temper of secondary school students of the sample was from 13 to 47 with actual possible scores ranging from 0-50.The mean score of scientific temper of was obtained as 33 with SEM of 0.188. The median and mode are 34 and 35 respectively. The distribution has a range of 34, SD of 6.32. The skewness value is -.442 (SES=.073) and the kurtosis value is -.251 (SEK=.145). Skewness and Kurtosis values within the range of ±2*(SE) are generally considered normal. With that rule skewness exceeds the limits of ±.146 whereas kurtosis is within the limits of ±0.29. The sample is found to be negatively skewed and the negative value of kurtosis indicates that the distribution is slightly platykurtic.

ii. The range of score obtained on the science motivation of secondary school students of the sample was from 12 to 100 with actual possible scores ranging from 0-100. The mean value of the scores obtained from the sample population is 66.85 with SEM of 0.433. The median and mode value are 68 and 71. The range and SD value are 88 and 14.58 respectively. The skewness value is -.450 (SES=.073) and the kurtosis value is .098 (SEK=.145). Skewness and Kurtosis values within the range of ±2*(SE) are generally considered normal. Here the given value of skewness is not within the range of ±.146 which means the distribution is found to be negatively skewed. With that rule kurtosis is within the limits of ±0.29, which is considered very normal. However the positive value of kurtosis indicates that the distribution is slightly leptokurtic.

iii. The range of score obtained on the science anxiety of secondary school students of the sample was from 30 to 140 with actual possible scores ranging from 30-150. The mean value of the scores obtained from the sample population is 96.39 with SEM of 0.457 and the median and mode are found to be 98 and 99 respectively. The distribution range and SD value are 110 and 15.40 respectively. The skewness value is -.664 (SES=.073) and the kurtosis value is .948 (SEK=.145). Skewness and Kurtosis values within the range of ±2*(SE) are generally considered normal. With that rule both skewness and kurtosis exceeds the limits of ±.146 and ±0.29 respectively indicating that the trait of science anxiety is bit non normal in distribution. The distribution negatively skewed and the positive value of kurtosis indicates that the distribution is leptokurtic.

iv. The range of score obtained on the emotional stability of secondary school students of the sample was from 41 to 76 with actual possible scores ranging from 30-81. The mean value of the scores obtained from the sample population is 57.60 with SEM of 0.152. The median value is 57 and the mode is 56. The range and SD value are 35 and 5.13 respectively. The skewness value is .237 (SES=.073) and the kurtosis value is -.030 (SEK=.145). Skewness and Kurtosis values within the range of ±2*(SE) are generally considered normal. Here the given value of skewness is not within the range of ±.146 which means the distribution is found to be slight positively skewed. However the value of kurtosis is within the limits of ±0.29. The very slight negative value of kurtosis indicates that the distribution is quite near normal bell shape.

v. The range of score obtained on the science achievement of secondary school students of the sample was from 21 to 96 with actual possible scores ranging from 0-100. The mean value of the scores obtained from the sample population is 57.04 with SEM of 0.447. The median and mode value are 56 and 47 respectively. The range and SD value are75 and 15.05 respectively. The skewness value is .110 (SES=.073) and the kurtosis value is -.481 (SEK=.145). Skewness and Kurtosis values within the range of ±2*(SE) are generally considered normal. With that rule skewness is within the limits of ±.146 whereas kurtosis exceeds the limits of ±0.29. Considering the skewness and kurtosis statistics, the data description indicate that the science achievement (Sc. Ach.) scores of secondary school students are reasonably normally distributed. There is slight positive skew such that there are more scores at the lower end of the distribution than a typical normal distribution. There is also a slight negative kurtosis indicating this distribution is slightly flatter than a normal distribution. It means the distribution is slightly platykurtic.

vi. The range of score obtained on the overall achievement of secondary school students of the sample was from 101 to 466 with actual possible scores ranging from 0-500. The mean, median and mode value of the scores obtained by the sample population are 301.70, 305 and 300 respectively with SEM of 2.11. The range and SD value are 365 and 71.21 respectively. The skewness value is -.232 (SES=.073) and the kurtosis value is -.539 (SEK=.145). Skewness and Kurtosis values within the range of ±2*(SE) are generally considered normal. With that rule both skewness and kurtosis exceeds the limits

of ±.146 and ±0.29 respectively indicating that the distribution of overall scores of students is slightly non-normal. There is very slight negative skew such that there are more scores at the high end of the distribution than a typical normal distribution. This reveals that the level of overall achievement is towards the higher side in the sample population which is desirable. There is also a slight negative kurtosis indicating this distribution is slightly flatter than a normal distribution. It means the distribution is slightly platykurtic.

5.1.1.2 Findings related to Frequency Distribution and Percentage of the Students' Scores on all the independent affective variables

For the purpose of frequency distribution of students' scores on all the four affective variables the scores were segregated into five levels ranging from low/poor, below moderate, moderate/average, above moderate and high levels.

i. 28.04% of the total students seem to possess scientific temper of average and below average level with no student falling into the category of poor/low scientific temper which is a very welcoming scenario. A majority of students, approximately 72% of them possess an above average and high degree of scientific attitude which is a desirable figure. The students with above average scientific temper were found to be maximum in the sample population with a total percentage of 56.61 %. Further comparison of mean science achievement scores of four obtained categories of scientific temper revealed that that students possessing high scientific temper scored highest mean score in science (M=62.27, SEM=1.132) followed by students possessing above average scientific temper with a mean score in science (M=59.42, SEM=0.5609), students with average scientific temper with a mean score in science (M=49.99, SEM=0.8162) and students with below average scientific temper who obtained lowest science average score (M=41.92, SEM=2.135).

ii. 28.92% of the total students possess high science motivation and 57.58% of students possess above moderate level of science motivation together accounting for 86.5 % of the total students. This figure indicates that the sample population has an above average level of science motivation in general. There were no students with absence of science motivation and only five students possessed a low science motivation score. Nearly 13.05% students possessed a moderate level of science motivation. The comparison of mean science achievement score on the different levels of science motivation revealed that the student possessing high science motivation had the highest mean science score (M= 62.99, SEM=0.8083) followed by students possessing above moderate level of science motivation (M= 55.92, SEM=0.5601). However, exceptionally students possessing low science motivation (M= 54, SEM=3.317) scored better than moderate motivation group with mean science achievement score being the least (M= 48.83, SEM=1.177).

iii. From the frequency distribution it was found that maximum students (55.64 %) possessed a moderate level of science anxiety with a good percentage of above moderate science anxiety (30.42%) and a comparatively less percentage of below moderate science anxiety (11.73%) levels in the sample population. A relatively negligible percentage of students (0.53%) had a low science anxiety level and a comparatively more percentage of students (1.68%) showed high science anxiety level. A comparison of mean science scores of low, below moderate, moderate, above moderate and high science anxiety group revealed that both moderate (M= 57.44, SEM=0.5989) and above moderate (M= 58.01, SEM=0.7497) science anxious groups showed better performance in science compared to the high (M= 50.67, SEM=6.048), low (M= 51.11, SEM=3.875) and below moderate (M= 53.69, SEM=1.474) science anxious groups.

iv. The distribution of scores depicted that more than half of majority (65.26%) possess a moderate level of emotional stability. There are relatively less students in below moderate (7.32%) emotional stability level and no student is found to possess a low emotional stability level but there are relatively more students to possess above moderate emotional stability (26.46%) and 11 students scored above 70 in their emotional stability scores (0.97%). A comparison of mean science scores of below moderate, moderate, above moderate and high emotional stability group revealed that group with highest level of emotional stability also scored high on science. The mean science score of all the observed groups are decreasing as their emotional stability level are decreasing. The group with high emotional stability has a mean science score of (M= 63.91, SEM=4.102)followed by above moderate (M= 62.39, SEM=0.8548), moderate (M= 55.39, SEM=0.5397) and low emotional stability group (M=51.73, SEM=1.531).

5.1.2 Finding relating to Differential Analysis

5.1.2.1 Findings Related to Significance of Differences between High and Low Achievers in Science with regard to Selected Affective Variables

i. There is statistically significant difference between the mean scientific temper scores of high achievers in science (M= 35.363, SD=5.108) and mean scientific temper scores of low achievers in science (M=30.013, SD=6.665). Scientific temper of high achievers is greater than that of low achievers.

ii. The students' response against all the five dimensions of scientific temper scale revealed that they scored maximum against 'objectivity' dimension of scientific temper with mean value of 8.09 followed by curiosity(7.10), rationality(6.78) and open mindedness(6.51) and minimum against 'aversion to superstition' dimension of scientific temper with mean value of 4.52. Further the analysis of significance of differences of the high and low science achievers on each sub dimension of scientific temper revealed that for all the five dimensions of Scientific Temper Scale there is statistically significant difference. In all the dimensions the high achievers in science scored higher mean scientific temper score than those of low achievers.

iii. There is statistically significant difference between the mean science motivation scores of high achievers in science (M=72.327, SD=13.484) and mean science anxiety scores of

low achievers in science (M=60.307, SD=14.350. The science motivation of high achievers is greater than that of low achievers.

iv. The students' response on each of the dimensions of science motivation were analyzed and the findings revealed that students scored maximum under grade motivation dimension with mean value of 14.98 followed by career motivation(14.79), intrinsic motivation(13.68) and self-efficacy(12.17) and minimum under self-determination with mean value of 11.18. Further the analysis of significance of differences of the high and low science achievers on each sub dimension of science motivation revealed that for all the five dimensions there is statistically significant difference. In all the dimensions the high achievers in science had higher mean science motivation score than those of low achievers.

v. There is statistically significant difference between the mean science anxiety scores of high achievers in science (M= 97.56, SD=14.26) and mean science anxiety scores of low achievers in science (M= 92.79, SD=15.94). The science anxiety of high achievers is greater than that of low achievers.

vi. The analysis of responses of students on each of the six dimensions of science anxiety revealed that they scored maximum for fear of testing dimension with mean value of 18.08 followed by performance in front of others(17.13), content mastery(16.08), parents' expectation(15.42), teachers' behaviour, teaching style and teaching environment(14.84) and minimum for application of science with mean value of 14.49. The findings further revealed that except 'Fear of Testing' dimension on all other dimensions students were found to be moderately science anxious. Further the analysis of significance of differences of the high and low science achievers on each sub dimension revealed that for four dimensions of science anxiety there is statistically significant difference between the mean science anxiety scores of high and low achievers in science which are Fear of testing, Application of science, Performance in front of others and Content mastery. On these dimensions high achievers are found more anxious except the dimension 'application of science' on which low achievers are found more anxious. However, there is no significant difference between the mean scores for two dimensions of SAQ: Teachers' behaviour, teaching style and teaching environment and Parents' expectation.

vii. There is statistically significant difference between the mean emotional stability scores of high achievers in science (M=59.18, SD=5.152) and the mean emotional stability scores of low achievers in science (M= 56.04, SD=4.611).The emotional stability of high achievers is greater than that of low achievers.

5.1.2.2 Finding Related to Gender Differences on Selected Affective Variables

i. The scientific temper of secondary school students does not vary with respect to their gender. The mean scores of boys and girls on all the five dimensions of scientific temper did not vary much. However the standard deviation for girls was comparatively higher than boys except for the dimension rationality.The test of association also revealed that scientific temper is independent of gender.

ii. The science motivation of secondary school students vary with respect to their gender with boys being more science motivated. The mean scores of boys and girls on all the

five dimensions of science motivation differed slightly with boys' average being slightly higher except for the dimension grade motivation where girls had higher mean score. The test of association also revealed that science motivation is not independent of gender.

iii. The science anxiety of secondary school students vary with respect to their gender with girls being more science anxious. The mean scores girls on all the six dimensions of science anxiety were found to be higher than those of boys. However, girls differed very slightly in their mean scores from boys especially for dimension Performance in front of others and Teachers' behavior dimension. For all the dimensions the standard deviation for both boys and girls was almost found to be similar. The test of association also revealed that science anxiety is not independent of gender.

iv. The emotional stability of secondary school students vary with respect to their gender with boys being more emotionally stable. However the test of association revealed that emotional stability is independent of gender for the sample. This could be because the statistical test used for former analysis is stronger than the later and hence was able to detect the difference in emotional stability of students with respect to gender with greater precision which the later could not.

v. The science achievement of secondary school students vary with respect to their gender. The science achievement of boys is better than girls. However, the overall achievement of secondary school students does not vary with respect to their gender.

vi. The comparison of gender within the high achieving group in science revealed that there was no significant difference in their scientific temper and science motivation. However there is significant difference with regard to their science anxiety and emotional stability, wherein high achieving girls are found to more science anxious than high achieving boys and the high achieving boys are found to be more emotionally stable than the high achieving girls.

vii. A similar comparison of gender within the low achieving group in science revealed that there was no significant difference in their scientific temper, science motivation, science anxiety and emotional stability.

Table 5.1 presents the summary of the decisions on Hypotheses Testing.

Table- 5.1
Decision about Testing of Hypotheses

S.No.	Research Hypothesis (H)	Null Hypothesis (Ho)	Decision on Null Hypothesis	Level of Significance
1.	High achievers in science have higher level of scientific temper whereas low achievers in science have a lower level of scientific temper.	There is no significant difference between high and low achievers in science with respect to scientific temper.	Ho Rejected	0.01
2.	High achievers in science have higher level of scientific temper on 'Curiosity' dimension than the low achievers.	There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'Curiosity'.	Ho Rejected	0.0001
3.	High achievers in science have higher level of scientific temper on 'Open mindedness'' dimension than the low achievers.	There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'Open mindedness'.	Ho Rejected	0.0001
4.	High achievers in science have higher level of scientific temper on 'Objectivity' dimension than the low achievers**.**	There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'Objectivity'.	Ho Rejected	0.0001
5.	High achievers in science have higher level of scientific temper on 'Rationality' dimension than the low achievers.	There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'Rationality'.	Ho Rejected	0.0001
6.	High achievers in science have higher level of scientific temper on 'Aversion to Superstition' dimension than the low achievers.	There is no significant difference between high and low achievers in science with respect to scientific temper measured through the dimension 'Aversion to Superstition'.	Ho Rejected	0.0001
7.	High achievers in science have higher level of science motivation whereas low achievers in science have a lower level of science motivation.	There is no significant difference between high and low achievers in science with respect to science motivation.	Ho Rejected	0.01
8.	High achievers in science have higher level of science motivation on 'Intrinsic Motivation' dimension than the low achievers.	There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Intrinsic Motivation'.	Ho Rejected	0.0001
9.	High achievers in science have higher level of science motivation on 'Career Motivation' dimension than the low achievers.	There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Career Motivation'.	Ho Rejected	0.0001

10.	High achievers in science have higher level of science motivation on 'Self-Determination' dimension than the low achievers.	There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Self-Determination'.	Ho Rejected	0.0001
11.	High achievers in science have higher level of science motivation on 'Self-Efficacy' dimension than the low achievers.	There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Self-Efficacy'.	Ho Rejected	0.0001
12.	High achievers in science have higher level of science motivation on 'Grade Motivation' dimension than the low achievers.	There is no significant difference between high and low achievers in science with respect to science motivation measured through the dimension 'Grade Motivation'.	Ho Rejected	0.0001
13.	High achievers in science have right level of science anxiety whereas low achievers in science have a higher level of science anxiety.	There is no significant difference between high and low achievers in science with respect to science anxiety.	Ho Rejected	0.01
14.	Low achievers in science have higher level of science anxiety on 'Fear of Testing' dimension than the high achievers.	There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Fear of Testing'.	Ho Rejected	0.01
15.	Low achievers in science have higher level of science anxiety on 'Application of Science' dimension than the high achievers.	There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Application of Science'.	Ho Rejected	0.01
16.	Low achievers in science have higher level of science anxiety on 'Performance in front of others' dimension than the high achievers.	There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Performance in front of others'.	Ho Rejected	0.01
17.	Low achievers in science have higher level of science anxiety on 'Teachers' behaviour, Teaching style and Teaching environment' dimension than the high achievers.	There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Teachers' behaviour, Teaching style and Teaching environment'.	Ho Accepted	**NS**
18.	Low achievers in science have higher level of science anxiety on 'Content Mastery' dimension than the high achievers.	There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Content Mastery'.	Ho Rejected	0.01

19.	Low achievers in science have higher level of science anxiety on 'Parents' Expectation' dimension than the high achievers.	There is no significant difference between high and low achievers in science with respect to science anxiety measured through the dimension 'Parents' Expectation'.	Ho Accepted	**NS**
20.	High achievers in science have higher level emotional stability whereas low achievers in science have a lower level of emotional stability.	There is no significant difference between low and high achievers in science with respect to emotional stability.	Ho Rejected	0.01
21.	There is a significant difference in scientific temper with respect to gender.	There is no significant gender difference in secondary school students with respect to their scientific temper.	Ho Accepted	**NS**
22.	There is a significant association between gender and level of scientific temper.	There is no significant association between gender and level of scientific temper.	Ho Accepted	**NS**
23.	There is a significant difference in science motivation with respect to gender.	There is no significant gender difference in secondary school students with respect to their science motivation.	Ho Rejected	0.02
24.	There is a significant association between gender and level of science motivation.	There is no significant association between gender and level of science motivation.	Ho Rejected	0.01
25.	There is a significant difference in science anxiety with respect to gender.	There is no significant gender difference in secondary school students with respect to their science anxiety.	Ho Rejected	0.01
26.	There is a significant association between gender and level of science anxiety.	There is no significant association between gender and level of science anxiety.	Ho Rejected	0.01
27.	There is a significant difference in emotional stability with respect to gender.	There is no significant gender difference in secondary school students with respect to their emotional stability.	Ho Rejected	0.05
28.	There is a significant association between gender and level of emotional stability.	There is no significant association between gender and level of emotional stability.	Ho Accepted	**NS**
29.	There is a significant difference in science achievement with respect to gender.	There is no significant gender difference in the secondary school students with respect to science achievement.	Ho Rejected	0.01
30.	There is a significant difference in overall achievement with respect to gender.	There is no significant difference between boys and girls of the secondary school students with respect to overall achievement.	Ho Accepted	**NS**
31.	There is significant difference in scientific temper of high achievers with respect to gender.	There is no significant difference in scientific temper of high achievers with respect to gender.	Ho Accepted	**NS**
32.	There is significant difference in science motivation of high achievers with respect to gender.	There is no significant difference in science motivation of high achievers with respect to gender.	Ho Accepted	**NS**
33.	There is significant difference in science anxiety of high achievers with respect to gender.	There is no significant difference in science anxiety of high achievers with respect to gender.	Ho Rejected	0.01

34.	There is significant difference in emotional stability of high achievers with respect to gender.	There is no significant difference in emotional stability of high achievers with respect to gender.	Ho Rejected	0.05
35.	There is significant difference in scientific temper of low achievers with respect to gender.	There is no significant difference in scientific temper of low achievers with respect to gender.	Ho Accepted	**NS**
36.	There is significant difference in science motivation of low achievers with respect to gender.	There is no significant difference in science motivation of low achievers with respect to gender.	Ho Accepted	**NS**
37.	There is significant difference in science anxiety of low achievers with respect to gender.	There is no significant difference in science anxiety of low achievers with respect to gender.	Ho Accepted	**NS**
38.	There is significant difference in emotional stability of low achievers with respect to gender.	There is no significant difference in emotional stability of low achievers with respect to gender.	Ho Accepted	**NS**

NS meansresearch hypothesis found non-significant at 0.05 level of significance.

5.1.3 Finding relating to Correlational Analysis

The correlation analysis was performed to analyze the strength of relationship between all the studied affective variables and science achievement of students. A similar analysis of strength of relationship was also done between the affective variables and overall achievement of students. Further partial, semi-partial and multiple correlations was performed to understand the net and collective impact of affective variables on the students' science and overall achievement was also performed. Following are the findings of correlation analysis.

i) The level of scientific temper of students is positively and significantly related to science achievement.
ii) The level of science motivation of students is positively and significantly related to science achievement.
iii) The level of science anxiety of students is positively and significantly related to science achievement.
iv)The level of emotional stability of students is positively and significantly related to science achievement.
v) The level of scientific temper of students is positively and significantly related to overall academic achievement.
vi) The level of science motivation of students is positively and significantly related to overall academic achievement.
vii) The level of science anxiety of students is positively and significantly related to overall academic achievement.
viii) The level of emotional stability of students is positively and significantly related to overall academic achievement.
ix) It is observed that as the effect of one or more affective variable is partialed out the strength of relationship between dependent and independent variables of concern is getting decreased suggesting then net relationship between any affective variable with science achievement/overall achievement always tends to decrease. It means all the confounding affective variables also

contribute positively to the zero order relationship. However the correlation is increasing in few exceptional cases. Similar pattern in partial correlation of first, second and third order is observed for both the dependent variables of science achievement and overall academic achievement.

x) The collective impact of the affective variables on the science achievement than their net impacts. 18% of the variance in the predicted dependent variable (science achievement) is determined by the collective influence of all four independent variables which decreases to 17% upon removing the effect of science anxiety.

xi) The collective impact of the affective variables on the overall academic achievement than their net impacts. 21% of the variance in the predicted dependent variable (overall achievement) is determined by the collective influence of all four independent variables which decreases to 19% upon removing the effect of science anxiety.

5.1.4 Finding relating to Situational Analysis

Situational analysis tried to investigate the research objective of assessment of the situational classroom related variables in context of science teaching learning practices. Following are some of the major finding of this analysis

i) There is a dearth of good science education and laboratory culture is very much in its infancy at secondary level of schooling.

ii) Question answers are made to be learnt through memorization by the students in order to pass the exams even at secondary level.

iii)The student's perception towards the science subject is in a confused shape as most of them don't want to opt it for higher education.

iv)The state requires a huge brigade of trained science teachers to cater to the demand of good science teachers at elementary and secondary level.

v) After the state has implemented the 'no detention policy' during the elementary years of children, teachers are bound to make science teaching very dilute for students in absence of which students could not be promoted smoothly to the next class.

vi) It was observed that in majority of government schools there is a heavy detention in class IX, as a result of which many student do not reach class X.

vii) The medium of instruction for science teaching is mother tongue till elementary stages and from secondary classes it is bilingual and students have to answer the subject questions in English at secondary level. There is lack of science text book in mother tongue which is another big reason of students' poor performance in the subject.

viii) As evidenced through the sample both students and teachers felt the constant threat to achieve better in science and those who achieved higher were found to be more science anxious.

ix) The parameters of judging a students' performance in science are very rudimentary emphasizing more on memorization and non-rational thinking. As far as teachers are concerned their focus was mainly to get good passing percentage in their respective science classes as the board results have been consistently projecting students' underperformance in science.

x) Culture of study camps for secondary schools was observed by the researcher mainly in the private schools which was a good practice for collaborative and peer learning.

5.1.5 Finding related to Logical Analysis

Logical analysis was performed to understand the complementarities between scientific temper and nature of science (NOS) which was one of the qualitative objectives of the study. The findings are mainly based on the review of available literature.

Following are the points of complementarities between the two construct:

i) The very first NOS is that there is no fixed scientific method but 'trial and error' method is the heart of any scientific expedition which is also based on evidence. A scientifically tempered person always looks for evidences to judge any situation. He/she tries to evaluate things, situations and circumstances in the light of evidence.

ii) NOS advocate the importance of process over content. Similarly, a scientifically tempered person tests the factual knowledge for its validity and does not simply believe on any propaganda or statement. He/she applies the process of sciences to derive meaningful conclusions.

iii) Thirdly, it is felt that proper analysis of contexts are very important in any decision making process. There is nothing wrong in being contextualized and the real NOS appreciate its significance. In the same way lack of rigidity in the attitude helps a scientifically tempered person to be more adaptive to changing times. He/she sees things in light of contexts and rely on holistic inferences and not single observation.

iv) Finally, the real NOS is honest inquiry where a scientist is not held responsible for the unpredictable consequence of a scientific finding. Hence reliable scientific knowledge is value-free and has no moral or ethical concern. In light of this conception the nature of science is very unpredictable and a scientifically tempered person knows how to judge a scientific discovery or invention in the light of morality.

5.2 Discussion

The descriptive analysis revealed the nature of distribution of the affective traits of secondary school students along with their science and overall achievement. The skewness and kurtosis statistics indicate that the scientific temper (ST) scores of secondary school students are reasonably normally distributed. There is slight negative skew such that there are more scores at the high end of the distribution than a typical normal distribution. This reveals that the level of ST is towards the higher side in the sample population which is desirable. There is also a slight negative kurtosis indicating this distribution is slightly flatter than a normal distribution. It means the distribution is slightly platykurtic. The differential analysis revealed that scientific temper of secondary school students vary between low and high achievers. Scientific temper of high achievers is greater than that of low achievers which suggests that a good level of scientific

temper is a pre-requisite for good performance in science. The scientific temper of secondary school students does not vary with respect to their gender. The comparison of scientific temper both within the high achieving and low achieving groups did not differed significantly with regard to gender. It means the trait of scientific temper is independent of the effect of gender.It is quite evident from the findings of the present study that the level of scientific temper of secondary students in Mizoram is in desirable range. It is very much welcoming to find that none of the students were placed in the range of poor scientific temper. The sub dimensions of scientific temper as measured through the scale are 'curiosity', 'open mindedness', 'objectivity', 'rationality' and 'aversion to superstition' against which the scores of students were analyzed and it was found that they scored more than average in all the dimensions except for the dimension aversion to superstition. It means that students are having a bend of mind towards certain cultural beliefs and they do not seem to judge situations in the light of scientific explanation all the time. There were also no gender differences observed for this particular dimension revealing that the adherence to cultural beliefs was very much free of gender influence. However, they scored maximum for the dimension of objectivity followed by curiosity, rationality and open mindedness. This is very good indicator of the healthy level of their scientific temper and it very much harmonizes with the notion of the nature of science.

The data description indicates that the science motivation (SM) scores of secondary school students are also reasonably normally distributed. There is slight negative skew such that there are more scores at the high end of the distribution than a typical normal distribution. This reveals that the level of SM is towards the higher side in the sample population which is desirable. There is also a slight positive kurtosis indicating this distribution is slightly narrower than a normal distribution. It means the distribution is slightly leptokurtic. Differential analysis revealed that science motivation of secondary school students vary between low and high achievers. The science motivation of high achievers is greater than that of low achievers which suggest that highly science motivated students tend to perform better in science. The science motivation of secondary school students vary with respect to their gender such that boys were more motivated for learning science than the girls. The comparison of science motivation both within the high achieving and low achieving groups did not differed significantly with regard to gender. It means the trait of science motivation although varies with gender but within high and low achieving groups it does not vary much.From the findings of the present study it is revealed that the level of science motivation of secondary students in Mizoram is towards a higher range. The sub dimensions of science motivation as measured through the SMQ II are 'intrinsic motivation', 'career motivation', 'self-determination', 'self-efficacy' and 'grade motivation' against which the scores of students were analyzed and it was found that they scored more than average in all the dimensions. They scored maximum for the dimension of grade motivation followed by career motivation, intrinsic motivation, self-efficacy and self-determination. The findings are in agreement with earlier studies(Bryan, Glynn & Kittleson2011;Salta & Koulougliotis,2015;Chumbley, Haynes & Stofer,2015). It indicates students are maximally motivated to perform better in sciences in order to get good grades, find a good career option and

to some extent they have more than a moderate level of intrinsic motivation. However, the level of self-efficacy and self-determination are of average level, which needs to be improved further. It conveys a meaning that students are not self-motivated and confident for doing academically better in science which may be due to lack of some favorable environmental factors.

The data description indicates that the science anxiety (SA) scores of secondary school students are not normally distributed. There is slight negative skew such that there are more scores at the high end of the distribution than a typical normal distribution. This suggests that the level of SA is towards the higher side in the sample population which is undesirable. The positive value of kurtosis means that there is more data towards the tails and less data is in middle indicating this distribution is slightly narrower than a normal distribution which means the distribution is slightly leptokurtic. Differential analysis revealed that science anxiety of secondary school students vary between low and high achievers. Interestingly, the science anxiety of high achievers is greater than that of low achievers which agrees with the fact that science anxiety at its minimal levels does not interferes with student's performance in science.It also means that the high achieving group experienced more anxiety on all the dimensions of science anxiety. The science anxiety of secondary school students vary with respect to their gender such that girls were found to be more science anxious than the boys. The comparison of science anxiety within the high achieving group varied with regard to gender, wherein high achieving girls were found to be more science anxious than high achieving boys. However a similar comparison within low achieving group showed that no such differences with regard to gender exist. The findings further revealed that students scored maximum for 'fear of testing' dimension followed by 'performance in front of others', 'content mastery', 'parents' expectation', 'teacher's behavior…' and minimum for 'application of science'. It meant that except for the dimension 'Fear of Testing' on all other dimensions students were found to be moderately science anxious. It means 'fear of testing' dimension contributed maximally to their science anxiety. However on all the dimensions more than average level of anxiety was observed which suggests that students acquire a certain amount of nervousness when they associate themselves with things related to science.

The data description indicates that the emotional stability (ES) scores of secondary school students are reasonably normally distributed. There is very slight positive skew such that there are slightly more scores at the lower end of the distribution than a typical normal distribution. This reveals that the level of ES is more or less moderate in the sample population which is not a bad sign. There is a negligible amount of negative kurtosis indicating this distribution is near normal identical to bell shape of normal curve. Differential analysis revealed that emotional stability of secondary school students vary between low and high achievers. The emotional stability of high achievers is greater than that of low achievers. The emotional stability of secondary school students vary with respect to their gender such that boys were more emotionally stable than the girls. The comparison of emotional stability within the high achieving group varied with regard to gender, wherein high achieving boys were found to be

more emotionally stable than their counter parts. A similar comparison within low achieving group showed that emotional stability did not varied with regard to gender.

The data description indicates that the science achievement (Sc. Ach.) scores of secondary school students are reasonably normally distributed. There is slight positive skew such that there are more scores at the lower end of the distribution than a typical normal distribution. This suggests that the level of science achievement is moderately uniform with slightly more distribution of scores below the mean value which is acceptable for a population. There is also a slight negative kurtosis indicating this distribution is slightly flatter than a normal distribution. It means the distribution is slightly platykurtic. The science achievement of secondary school students vary with respect to their gender such that boys' achievement was better than the girls.

The data description indicates that the science achievement (Sc. Ach.) scores of secondary school students are reasonably normally distributed. There is slight positive skew such that there are more scores at the lower end of the distribution than a typical normal distribution. This suggests that the level of science achievement is moderately uniform with slightly more distribution of scores below the mean value which is acceptable for a population. There is also a slight negative kurtosis indicating this distribution is slightly flatter than a normal distribution. It means the distribution is slightly platykurtic. The overall achievement of secondary school students does not vary with respect to their gender.

The existing levels of all the affective variables in the secondary students had a positive and significant impact on their science achievement; however the magnitude of their strength was low. Since the nature of the variables is affective, even a low positive correlational relationship has a meaning to convey. Even science anxiety, which in general is treated as a negative affect seems to have positive effect on student's science achievement. The strength of this magnitude is highest for scientific temper, followed by science motivation, emotional stability and the lowest magnitude is for science anxiety almost nearing 0.1. This suggests that science anxiety being a negative affect share the weakest positive relationship with science achievement. It somehow seems that the effect of science anxiety within the students is within the natural threshold limits which contribute to science achievement. However high level of science anxiety is always a matter of worry as it negatively interferes with the student's performance but in present finding it is not influencing the student's performance negatively. The collective effect the entire affective variable accounted to be 18% in terms of their prediction of student's science achievement, which decreased by 1% when the impact of science anxiety was removed. It suggested that some minimal threshold level of science anxiety in fact positively contributed to the science achievement of students. A similar analysis of the collective impact of all the affective variables on the overall academic achievement revealed that nearly 21% of the variance in the students' science achievement is predicted by the these affective variable. Again it decreased by 2% if the effect of science anxiety was removed. This again supports the fact that science anxiety had a positive impact on students' achievement at some threshold level.

5.3 Educational Implications of the Research Findings

On the basis of findings and discussions of the present study following educational implications are the highlights of the study:

i) Students' affect are having significant impact on their achievement in science and academic achievement. A good climate of science classroom which takes into consideration of learners' affect can contribute positively to the students' science achievement. Students are seldom engaged entirely into learning when their affects are unfavorable. It decides the learners' readiness or remoteness for the learning process. Learners' positive affects are thus required to be nurtured in science classroom such as their happiness, interests, motivation, positive group behaviour interactions, self-confidence, temperament, self-efficacy and moods. Involving affect into teaching and learning science will be a life changing experience for both teachers and learners which they will cherish for rest of their lives.

ii)Laboratory culture is a key means to provides students hands on training on process skills and it needs to be strengthen and revitalized right from elementary stages to higher stages of schooling. This is a prime pre-requisite for ensuring better performance of students in science.

iii)Rote learning at secondary level of education is doing more harm than benefits it seems to offer. The general perception of students towards science is that it is a hard, hostile, abstract and dry subject as they are unable to feel the charm of subject through mere memorization.

iv) Student level factors such as their level of scientific temper and science motivation are quite favourable suggesting student want to learn science and science holds a key position in school curriculum for them. The positive affect of students towards science subject are needed to be readily incorporated both inside and outside classroom teaching-earning situations.

v) Students' achievement is very much controlled by school and outside school factors apart from individual factor. The high level of science anxiety and moderate level of emotional stability of students suggest that environment both at school and home may not be so favorable that enables them to combat their fear associated with science.

vi) The science anxiety of high achievers is greater than that of low achievers which implies that science anxiety at its minimal threshold level does not interferes with student's performance in science.

vii)Nature of science (NOS) needs to be properly addressed through science curriculum to clarify students' popular misconceptions about science. Science education in modern times has given rise to certain phobias which are actually not defining the real nature of science.

viii) The present curriculum of science is a mismatch in terms of non-relatedness across different sciences as concepts across various sciences find fewer inter-linkages. Sometime curriculum seems to be unfamiliar, alien devoid of actual contexts happening due to over increasing load on

science curriculum to accommodate more and more content owing to new findings, changes in the knowledge patterns on one hand and on the other hand because of the curriculum construction process which follows the traditional approach of addressing only the cognitive domain of the learners. Therefore revamping of science curriculum in this regard is an immediate requirement to facilitate students' smooth science learning. A proper synchronization between the knowledge, attitudes and skills in science curriculum is the real need of hour in order to bring conceptual clarity and bridge the gaps of science learning.

ix) The team working culture of Mizo population should if utilized in science teaching-learning situations like organization of science fairs, exhibitions, clubs, olympiads, book-stalls can prove to positively contribute in students' achievement n science.

x) Science text books in mother tongue at higher elementary and secondary levels of education shall compliment to student's better understanding of the subject.

5.4 Recommendations

5.4.1 Recommendations Based on Findings

i.The national curriculum frameworks have been highlighting the ways of learning and doing school science in a manner that nurtures the inbuilt natural tendencies of learners such as curiosity, creativity, cooperative investigation and spirit of inquiry to reveal the real truth. Scientific temper is an affective construct of an individual and its manifestation as a trait in school students helps in science learning. It is defined as a frame of mind that accepts truth in its real form without subjecting it to any kind of influence. Science motivation is another affective construct in context of science education which refers to a psychological state of students that arouse them to perform better in science subject. Both these constructs positively influence a student's performance in science and hence their advantage readily needs to be incorporated in science classrooms. Both these construct are mainly student level factors; however environmental factors such as school, teachers, peer, parents etc. can also influence it. In the present student sample they are quite favourable suggesting that students want to learn science and science holds a key position in school curriculum for them. These positive affects of students towards science subject are needed to be readily incorporated both inside and outside classroom teaching-earning situations.

ii.Science Anxiety refers to the general fear or aversion by students toward science concepts and science-related activities as a whole and emotional stability refers to individuals' steadiness of mood and ability to remain calm when faced with pressure or stress. Both these construct are very much by-product of students level intrinsic factors and environmental extrinsic factors as the past studies have indicated. The secondary school students in the present sample in general showed high level of science anxiety and moderate level of emotional stability suggesting that environment both at school and

home may not be so favorable that enables them to combat their fear associated with science. This also showed gender influence such that girls are found to be more science anxious and less science motivated. This scenario of the sample needs to be addressed through proper investigation of family and school level factors that seem to be positively contributing to it. Gender associated behaviour in context of science subject needs to be more minutely investigated. One can fairly construct knowledge in science if one is less science-anxious. Highly science–anxious students fail to construct knowledge because their emotional state does not allow them. However, a minimal threshold level of science anxiety is not a very serious botheration as it is not negatively impacting the student's performances in science nevertheless the high level of science anxiety needs to be minimized through teacher's intervention.

iii.Studies of attitudes in to school science show that children's attitudes towards science appear to become less positive as they progress through early stages of schooling, and become even less positive as they move on to higher levels which remains unclear (Koballa in Watts & Alsop, 1997). It suggests by the time students reach higher grades they accept the fact that science is hot (modern terminology), hard, hostile and sometime historically elite subject and they adjust with the requirement of being an ideal science student who is cognitively sound and emotionally inert. Often in doing so, they mask their emotions, pretending to be emotionally balanced and use coping strategies to resist emotional inclination. This is what the science students learn in the process of schooling conforming to the contemporary science standards. What they fail to learn is that science is for all; science is an interactive discipline which needs constant engagement with the content and discourse on environmental and social phenomenon; and that science learning is enhanced and supported by positive affect. The real nature of science is in the most compromised state in school science curriculum. The core nature of science is its dynamism which makes it very appealing. Contradicting this school science portrays a very insensitive image of world of science and people associated with the discipline. This leads to widening of gap between the intended and acquired school science curriculum. A misinterpreted nature of science is communicated to the students through traditional school science leading to misconceptions. This might also be the cause of falling interest of students in science as they grow up. This scenario was very evident in the present sample. Inspite of possessing favourable affective traits of scientific temper and science motivation, they seemed to lack desired level of aspiration to take up science in their higher education. They felt science teaching and learning practices as very incompatible to their expectations about science subject. It is felt by the researcher that school science practices need to be seriously revamped so that students try to understand the real nature of science.

iv. It is interesting to find that within the Mizo secondary school students, the gender differences on all the affective variables are quite moderate with no significant differences on the trait of scientific temper. It is a favourable condition for growth and development of society in a larger perspective. However girls need to be further motivated and aspired to perform better in sciences.

v. The affective traits of learner have a significant role in both science and overall academic achievement of students to such an extent that science teaching and learning process cannot to ignore it. A healthy affect of learner gets translated to improved performance of students in science and vice versa, is one of the vital recommendations of the present study.

5.4.2General Recommendations

Following are general recommendations based on the educational implications of the present study

i) Elementary science teachers should be given hands on training through state nodal agencies on ways to incorporate basic science process skills into science teaching-learning situations. Such basic skills include teaching students about process skills of observing, measuring, classifying, inferring, communicating, prediction, group investigation etc.

ii) At secondary school science students should be compulsorily taught higher order integrated process skills which by default involve the basic process skills. Such higher order skills are namely hypothesizing, controlling variables, designing experiments, investigating and writing the findings of experiment etc. this initial acquaintance of students to the ways of doing science will definitely arouse their interests in science and student will take science as fun and challenge and not treat it to be a difficult subject.

iii) There is a real need to strengthen the laboratory culture in the state. Debarring few exceptional missionary schools, the practice of going to laboratory at secondary level is totally absent. This condition is more severe in distant remote localities of state.

iv) Science exhibitions, fairs and Olympiads should be organized at secondary level on regular basis to cultivate more and more interest and enthusiasms within students towards science. School administrator needs to play key role in this initiative.

v) During study camps activities like nature walk, science clubs formation, making of low cost improvised science apparatus, collection of local flora and fauna samples, use of foldscopes (low cost portable microscopes) to explore nature should be arranged by school to develop interest within students towards nature and science.

vi) Common understanding of day to day basis scientific phenomenon should be encouraged through group activities, peer learning, brainstorming, debate, discussions and quizzes.

vii) Nature of science (NOS) should be compulsorily taught to students. This aspect of science has to be addressed through its incorporation into science curriculum, especially

at secondary level. NOS can be taught to students at elementary stage indirectly by linking it to science process skills as suggested by Bell (2008).

viii) Arrangement in the timetable should be made such that once in a week a science classroom is devoted to history of science wherein discussions are provided by science teachers on important discoveries, inventions, innovations and chance discoveries of in science. Through this students can be given an understanding of both possibilities and limitations of science and should be acquainted to the nature of science.

ix) The practice of rote memorization and learning through science guides needs to be abolished at secondary level of schooling. It has a negative effect on student's actual potential of doing good science.

x) The parameters of judging a students' performance in science are very rudimentary emphasizing more on memorization and non-rational thinking. This criterion of evaluating students needs to be reformed and students' should be evaluated on their mastery of process skills, ability of reasoning and rationalization, skill of questioning in classroom interactions, group activities like projects and experiments apart from content mastery. The existing criterions are very insufficient to properly evaluate students in science.

5.5 Suggestions for Future Research

The present study tried to answer various research questions as proposed during defining of the conceptual framework of the study. However, as the study proceeded many new questions emerged which could not be addressed within the present study. These research questions are translated into suggestions for future research which can fill in the research gaps further and strengthen the findings of present study. The suggestions are as follows:

i) A study should be undertaken where the collective impact of students' cognitive and affective factors is studied on students' achievement in science so that more precise relationship between students' affect and science achievement on one hand and students' cognition and science achievement on other hand can be established. Further the strongest predictor of student's success in science in future can be determined using regression analysis.

ii) A study may be conducted to understand the influence of socio-cultural background of students like their language preference, socio-economic status, locale etc. over their achievement in science.

iii) Research question emerged in context of understanding the parental attitude towards schooling as they are one of important stakeholders of school education. a study must be undertaken to understand what kind of attitude is borne by the parents of secondary school students for the choice of science education stream of their wards at higher secondary level.

iv)Also research needs to be undertaken to understand whether education of parents influence their ward's achievement in science and how far specifically mother's educational and professional status relate to her ward's achievement in science.

v) The present study should be expanded to other districts of Mizoram for better generalization of the study.

vi) There is a serious need to qualitatively study the classroom and laboratory delivery of science subject both at elementary and secondary level in the state along with the identification of the core co-scholastic activities in sciences taken up by different types of schools in Mizoram through case studies.

vii) A research must be undertaken to analytical quantify the types of process skills introduced to students during elementary years and secondary years using the technique of classroom interaction analysis.

viii) An experimental research should be conducted to see the impact of emotions on science achievement.

ix) A longitudinal study tracing the future academic preference of secondary students at higher secondary level should be done on the basis of their cognitive and affective profiles.

x) Construction of an achievement test in science for secondary level addressing both the aspects of content mastery and incorporation of age appropriate basic and integrated process skills should be taken as a research project.

xi) Finally, teacher being the real change maker for bringing reforms in current school science practices needs to be assessed on their understanding of nature of science (NOS) through construction of a questionnaire for the same. This can be done for elementary, secondary and higher secondary level teachers and a comparative profiling can be done for the three groups.

5.6 Conclusion

Today we live in a world which is more interdependent. Capacity building of every citizen of a nation thus automatically becomes the prime objective of all the stakeholders involved in nation building, one of them being the school. School is an enlarged family and miniature society. In that way on one hand, school serves as the bridge between the family and society at the entry point of schooling and on the other hand it serves as a bridge between school and society at the exit point of schooling. Henceforth, the whole process of schooling is a crucial period of a child's life right from early childhood to late adolescence. Science as a school subject has always been the highlight of school experience because of the commonality in the nature of science and learner. Both begin with a question. Science revolves around the learners as a magical fairy every time ready to unravel the mysteries of nature. Teachers can be the real change makers within the classroom and their impact lasts outside the classroom even as they are in nearest

proximity to the learners. They can bring in lot of positive changes within every single child by their magical touch, both physical and emotional. They share one of the most holy bonds, the bond of faith and respect for each other. A learner owes a high degree of expectation from their teachers and a responsible teacher cannot afford to ignore them. Affect instantly connects the teacher with the learner. Both learner and teacher can together make the experiences of the science classroom as the most happening experiences of their lives using the language of emotions to touch the untouched potential of cognition in stored within them. They are partners in joyful journey of learning and sharing, all which needs a healthy affect in and around them. It is sad that most science classroom consistently failed to realize the potential of affect in making science learning and teaching the most happening, impactful, adventurous and satisfying experience for both teacher and the learner and very lately the importance of affect has been acknowledged. This is a good sign of change in dynamics of traditional science classrooms and is welcomed by all. Hope the change brings out the best potential within a child while understanding, doing and feeling the real nature of science. It is never too late for a new beginning.

INDEX FOR APPENDICES

APPENDIX-1

Details of Sample of Students taken from Different Secondary Schools from Aizawl District

Serial no.	Name of Visited School	School Type	No. of Boys	No. of Girls	TOTAL	Block of Aizawl District	Place
1	Sihphir Venghlun High School.	Adhoc aided	17	28	45	Aizawl	Sihphir
2	Govt. High School Durtlang	Government	10	9	19	Aizawl	Durtlang
3	Govt. Chaltlang High School	Government	27	55	82	Aizawl	Chaltlang
4	R.S. School of Learning	Private	10	12	22	Aizawl	Ramnikawn
5	Govt. High School Sairang	Government/ RMSA	2	9	11	Aizawl	Sairang
6	John Memorial High School	Lumpsum Aided	22	33	55	Aizawl	Sairang
7	Govt. Sakawrtuichhun High School	Government	2	5	7	Aizawl	Sakawrtuichhun
8	Chawlhhmun High School	Adhoc aided	8	20	28	Aizawl	Chawlhhmun
9	Govt. Tanhril High School	Government	3	5	8	Aizawl	Tanhril
10	St. James School	Private	16	16	32	Aizawl	Chawlhhmun
11	Govt. CH. Chhunga High School	Government	5	2	7	Aizawl	Luangmual
12	Govt. K.M. High School	Government	28	43	71	Aizawl	Dawrpui Vengthar, Vaivakawn
13	Divine Intervention School	Private	24	14	38	Aizawl	Luangmual
14	Tuirial Secondary School	RMSA	4	4	8	Aizawl	Tuirial Airfield
15	Don Bosco School Seling	Private	14	15	29	Aizawl	Seling
16	Govt. High School Seling	Government	8	7	15	Aizawl	Seling
17	Govt. Mizo High School	Government	70	30	100	Aizawl	Zarkawt
18	St. Paul's Higher Secondary School	Deficit	41	52	93	Aizawl	Tlangnuam
19	Govt. Aizawl High School	Government	11	7	18	Aizawl	Republic
20	Synod Higher Secondary School	Deficit	6	17	23	Aizawl	Mission Vengthlang

21	**Providence Higher Secondary School (boys and girls section)**	**Private**	**38**	**25**	**63**	**Aizawl**	**Zarkawt**
22	**Presbyterian English School Keifang**	**Lumpsum aided**	**16**	**17**	**33**	**Saitual**	**Keifang**
23	**Presbyterian English School Saitual**	**Private**	**17**	**9**	**26**	**Saitual**	**Saitual**
24	**Govt. High School Saitual**	**Government**	**2**	**4**	**6**	**Saitual**	**Saitual**
25	**Saitual High School-II**	**Adhoc**	**5**	**5**	**10**	**Saitual**	**Saitual**
26	**T.M. High School Sesawng**	**RMSA**	**11**	**12**	**23**	**Aizawl**	**Sesawng**
27	**Govt. Zoram High School**	**Government**	**5**	**8**	**13**	**Aizawl**	**Khawruhlian**
28	**Khanpui High School**	**Adhoc aided**	**7**	**8**	**15**	**Aizawl**	**Khanpui**
29	**Govt. Darlawn High School**	**Government**	**15**	**9**	**24**	**Darlawn**	**Darlawn**
30	**Presbyterian English School Darlawn**	**Private**	**6**	**10**	**16**	**Darlawn**	**Darlawn**
31	**Govt. Nehru Memorial High School NMHS**	**Government**	**3**	**6**	**9**	**Aizawl**	**Kepran**
32	**Rosebud School**	**Private**	**17**	**30**	**47**	**Aizawl**	**Ramhlun Venglai**
33	**Centenary School Dawrpuii Church**	**Private**	**23**	**36**	**59**	**Aizawl**	**Dawrpuii**
34	**St. Joseph Higher Secondary School**	**Private**	**39**	**40**	**79**	**Aizawl**	**Ramhlun North**
TOTAL			**532 (46.91 %)**	**602 (53.09 %)**	**1134**		

Source: Field Data

APPENDIX-2

SCIENTIFIC TEMPER SCALE (Prof. N. A. NADEEM and SHOWKAT RASHEED WANI)

DESCRIPTION OF THE TOOL

DESCRIPTION OF TOOL

1. SCIENTIFIC TEMPER SCALE

Scientific Temper Scale developed by Prof. N.A. Nadeem and Showkat Rasheed Wani was used to assess the scientific temper of secondary school students. The scale consists of 5 dimensions viz., curiosity, open mindedness, objectivity, rationality, aversion to superstition. The test is highly reliable having reliability co-efficient 0.89 (test-retest method).

Table - 1

Dimension	Operational Definitions	Sample item
Curiosity	• Desire for understanding new situations that are not explained by the existing body of knowledge. • Seeking to find out the 'why & 'how' of observed phenomenon. • Desire/quest to look at usual things in an unusual way.	Student should be curious to observe nature during field trip and educational tour.
Open Mindedness	• Willingness to revise opinions and conclusions in the light of new evidences and facts. • Rejection of Singular & Rigid approach to people, things & ideas.	In order to broaden the mental horizons it is important to make use of Information and Communication Technology (via email, internet)
Objectivity	• Demonstration of the greatest possible concern for observing & 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 and political influence. • Unwillingness to draw inferences before sufficient evidence is collected. • Unwillingness to accept facts that are not supported by the convincing proof. • Avoidance of quick judgment based on mere opinions.	Students should have the courage to question beliefs and practices.
Rationality	• Tendency to test traditional beliefs • Acceptance of criticalness • Identification of cause and effect relationship • Challenge of Authority.	Students should try to explore cause and effect relationship while explaining phenomenon / events.
Aversion to Superstitions	• Rejection of false beliefs • Acceptance of scientific facts and explanations.	People should not discriminate on the basis of caste, creed and colour.

Scoring:

The scientific temper scale comprises of 50 questions which are divided into five dimensions as follows.

Table - 2

S.No	Dimension	No. of Items	Positive polarity	Negative Polarity
1.	Curiosity	10	1, 2, 3, 4, 6, 7, 8, 9, 10	5
2.	Open Mindedness	10	11, 12, 13, 15, 18, 19	14, 16, 17, 20
3.	Objectivity	10	21, 22, 23, 24, 25, 26, 27, 29, 30	28
4.	Rationality	10	31, 33, 34, 35, 36, 37, 38, 40	32, 39
5.	Aversion to Superstitions	10	43.	41, 42, 44, 45, 46, 47, 48, 49, 50

The scoring of each individuals response sheet was done in accordance with the following criteria:

a. For positive Items – "1" for Yes and "0" for No.

b. For Negative Items – "0" for Yes and "1" for No.

During the collection of data there was same condition for the all the students and seating arrangement was proper and the chance of copying was eliminated.

SCORING KEY

Dimension I:

a. Item No's 1, 2, 3, 4, 6, 7, 8, 9, 10 = Yes.

b. Item No. 5 = No.

Dimension II:

a. Item No.'s 11, 12, 13, 15, 18, 19 = Yes

b. Item No.'s 14, 16, 17, 20 = No.

Dimension III:

a. Item No.'s 21, 22, 23, 24, 25, 26, 27, 29, 30 = Yes
b. Item No. 28 = No.

Dimension IV:

a. Item No.'s 31,33, 34, 35, 36, 37, 38, 40 = Yes
b. Item No.'s 32, 39 = No.

Dimension V:

a. Item No. 43 = Yes
b. Item No.'s 41, 42, 44, 45, 46, 47, 48, 49, 50 = No.

STANDARDIZATION OF SCALE

The scale has been standardized by estimating reliability, validity.

1) Reliability

a) Test —Retest Method

The test was administered on a sample of 100 students and after a gap of 1 month it was again administered and the coffient of correlation was worked out between the two set of scores

i. Test-retest method (N=100) 0.891

Split Half

Two halves prepared on the basis of upper half and lower half item were administered on a group of 200 students studying in class lx and X. After scoring, a coefficient of correlation was worked between the two set of scores obtained from the two halves. The following results were obtained between two set of scores obtained from the two halves

Split half

b) Upper-lower method (N=200) 0.761 0.864

(After applying spearman brown prophecy formula)

For determining odd even reliability index two halves were prepared on the basis of alternate items in each area. The two halves were administered on a

group of 200 students reading in class IX & X. The following results were obtained on correlating the two set of scores

c) **Odd-even method (N=200)** .791 .883

(After applying spearman brown prophecy formula)

d) Kuder Richardson Formula no 20

The coefficient of correlation was also worked as per Kuder Richardson Formula no 20 which came out to be .894

(a) Kuder Richardson formula = $\left(\frac{n}{n-1}\right)\left(\frac{\sigma^2-\sum pq}{\sigma^2}\right) = 0.894$

No 20 (N=100)

Validity

a) Content Validity

It was calculated as per the expert rating of the judges as mentioned at serial no 2.5

b) Construct validity (N=200)

A 6x6 correlation matrix was worked out. The result showed correlation positive, significant and high. This is an indirect measure of construct validity.

Table - 3: Inter-Correlation between the Dimensions of Scientific Temper (N=200)

	CU	OM	OB	RA	SU	TOTAL
CU	*	0.40	0.29	0.38	0.40	0.58
OM		*	0.51	0.56	0.51	0.74
OB			*	0.84	0.73	0.87
RA				*	0.82	0.92
SU					*	0.88

All correlation shown above are significant at 0.01 level.

c) **Concurrent Validity**

Concurrent validity (N=100)

The scores from the inventory were corrected with a standardized DN. Dani's scientific attitude scale (Vidya Bhawan, G.S. Teacher College Udaipur) and it came out to be .791.

Norms

Range of sources	Classification
40 & above	High scientific Temper
30-39	Above Average Scientific Temper
20-29	Average Scientific Temper
10-19	Below average Scientific temper
0-9	Poor Scientific Temper

SCIENTIFICT TEMPER SCALE

S. No.	ITEMS	Yes	UD	NO
1	2	3	4	5
1	I am curious to watch program on Discovery channel, Animal Planet, National Geographic Channel, Doordarshan and Radio and discuss it with my classmates.			
2	I am very much interested to observe nature during my field trips & educational tours.			
3	I am taking interest in visiting science exhibitions, science fairs and science clubs.			
4	When I observe a novel situation I ask myself how, why and where of this situation.			
5	While observing the astonishing situation I do not strive to know the underlying secret			
6	I am curios to look at usual things in an unusual way.			
7	I believe that a student should ask questions and seek answers beyond the prescribed science text book.			
8	I believe that one should try to understand why sky is blue, why earthquakes occur?			
9	I am eager to conduct new experiments.			
10	Students should have a quest for new knowledge and work beyond the traditional curriculum.			
11	Positive/healthy criticism benefits the advancement of knowledge.			
12	The scientist 'A' should modify his erroneous concepts if scientist 'B' presents the correct and fully tested facts before him.			
13	In order to broaden the mental horizons it is important to make use of Information & Communication Technology (via email, internet).			

14	A senior science teacher should not accept the new methodology suggested by the junior science teacher.			
15	In the light of the new discoveries and inventions we should be ready to change our conceptions based on mere customs, rituals and beliefs.			
16	I feel no matter how progress the world makes, we should work on our own way.			
17	I am of the opinion that science can be best taught within the four walls of the classroom.			
18	People should be willing to change their ideas if sufficient evidence about the hollowness of their ideas are available.			
19	Dialogue, discussion and other interactive methodology should be encouraged in our schools.			
20	It is right to follow blindly all the traditions & customs of our elders.			
21	Students should record honestly their observations.			
22	Students should ask what, how and why and find their answer critically by observing, experimenting, consulting, discussing and reasoning.			
23	Students should have the courage to question beliefs and practices.			
24	Students should never manipulate (change) their actual results of experiments under any circumstances, carried out in special labs.			
25	We should infer on the basis of true facts and figures gathered in the field.			
26	Science related articles should be published in newspapers, magazines and journals so that the people take interest in science.			

27	If a science teacher fails to arrive at the expected results during demonstrations he should try to discuss the possible causes of his failure with his colleagues.			
28	The best way to learn science is to learn it only from the prescribed textbooks.			1
29	The teachers should make use of local wisdom (for teaching electricity we can seek help of electrician) and other resources in teaching of science.			
30	Evaluation in science should be continuous and comprehensive.			
31	Experiments of adapting certain missile technology into certain socially useful medical products will benefit the entire humanity.			
32	It is disrespectful to question what the teacher teaches us in the class.			
33	Everything written in holy books should be interpreted in scientific/rational basis.			
34	One should be guided by reason and logic rather than by one's emotions.			
35	An idea should not be accepted as it is. It should rather be tested for its empirical verification.			
36	I am of the opinion that a conclusion based on insufficient evidences should summarily be rejected.			
37	I believe that hard work, consistency and sincerity of purpose is a key to success.			
38	If by mistake a student is awarded a prize for an effort he has not made, he should surrender the prize.			
39	New theory propounded by a senior and experienced scientist 'A' raised some doubts in the mind of junior and young scientist 'B'. The scientist 'B' should accept scientist 'A' theory uncritically without clearing his doubts.			1

40	I believe if student derives results which do not match with the key (answers) he should report honestly to the teacher.			
41	AIDS and other diseases are the product of divine anger.			1
42	It is better to consult a fakir or a Sadhu rather than a doctor.			1
43	We should not believe in bad omens like the journey must be cancelled if a cat crosses a path or someone sneezes.			
44	I like to watch horror movies on the television.			1
45	I believe in ghosts.			1
46	Natural calamities (earthquakes, storms) are due to divine anger.			1
47	I am of the opinion that cooked stories by astrologers and magicians should be preferred to scientifically based explanations.			1
48	Luck plays an important role in our life.		—	•
49	When traditional beliefs are in conflict with the scientific discoveries, it is better to accept traditional beliefs.			1
50	More importance should be attached to traditional beliefs than the new discoveries of science			1

APPENDIX-3
Dimension wise Splitting of Scientific Temper Scale

Dimension 1: Curiosity

1. I am curious to watch program on Discovery channel, Animal Planet, National Geographic channel, Doordarshan and Radio and discuss it with my classmates.
2. I am very much interested to observe nature during my field trips and educational tours.
3. I am taking interest in visiting science exhibitions, science fairs and science clubs.
4. When I observe a novel situation I ask myself how, why and where of this situation.
5. While observing the astonishing situation I do not strive to know the underlying secret.
6. I am curious to look at usual things in an unusual way.
7. I believe that a student should ask questions and seek answers beyond the prescribed science text book.
8. I believe that one should try to understand why sky is blue, why earthquakes occur?
9. I am eager to conduct new experiment.
10. Students should have a quest for new knowledge and work beyond the traditional curriculum.

Dimension 2: Open-Mindedness

1. Positive/ healthy criticism benefits the advancement of knowledge.
2. The scientist 'A' should modify his erroneous concepts if scientist 'B' presents the correct and fully tested facts before him.
3. In order to broaden the mental horizons it is important to make use of information & Communication Technology(via email, internet)
4. A senior science teacher should not accept the new methodology suggested by the junior science teacher.
5. In the light of the new discoveries and inventions we should be ready to change our conceptions based on mere customs, rituals and beliefs.
6. I feel no matter how progress the world makes, we should work in our own way.
7. I am of the opinion that science can be best taught within the four walls of the classroom.
8. People should be willing to change their ideas if sufficient evidence about the hollowness of their ideas available.
9. Dialogue, discussion and other interactive methodology should be encouraged in our schools.
10. It is right to follow blindly all traditions and customs of our elders.

Dimension 3: Objectivity

1. Students should record honestly their observations.
2. Students should ask what, how and why and find their answer critically by observing, experimenting, consulting, discussing and reasoning.
3. Students should have the courage to question beliefs and practices.

4. Students should never manipulate (change) their actual results of experiments under any circumstances, carried out in special labs.
5. We should infer on the basis of true facts and figures gathered in the field.
6. Science related articles should be published in newspapers, magazines and journals so that the people take interest in science.
7. If a science teacher fails to arrive at the expected results during demonstrations he should try to discuss the possible causes of his failure with his colleagues.
8. The best way to learn science is to learn it only from the prescribed textbooks.
9. The teachers should make use of local wisdom (for teaching electricity we can seek help of electrician) and other resources in teaching of science.
10. Evaluation in science should be continuous and comprehensive.

Dimension 4: Rationality

1. Experiments of adapting certain missile technology into certain socially useful medical products will benefit the entire humanity.
2. It is disrespectful to question what the teacher teaches us in the class.
3. Everything written in holy books should be interpreted in scientific rational basis.
4. One should be guided by reason and logic rather than by one's emotions.
5. An idea should not be accepted as it is. It should rather be tested for its empirical verification.
6. I am of the opinion that a conclusion based on insufficient evidences should summarily be rejected.
7. I believe that hard work, consistency and sincerity of purpose is a key to success.
8. If by mistake a student is awarded a prize for an effort he has not made, he should surrender the prize.
9. New theory propounded by a senior and experienced scientist 'A' raised some doubts in the mind of junior and young scientist 'B'. The scientist 'B' should accept scientist 'A' theory uncritically without clearing his doubts.
10. I believe if student derives results which do not match with key (answers) he should report honestly to the teacher.

Dimension 5: Aversion to Superstition

1. AIDS and other diseases are the product of divine anger.
2. It is better to consult a fakir or a sadhu or a pastor rather than a doctor.
3. We should not believe in bad omens like journey must be cancelled if a cat crosses a path or someone sneezes.
4. I like to watch horror movies on the television.
5. I believe in ghosts.
6. Natural calamities (earthquakes, storms) are due to divine anger
7. I am of the opinion that cooked stories by astrologers and magicians should be preferred to

scientifically based explanations.

8. Luck plays an important role in life.
9. When traditional beliefs are in conflict with the scientific discoveries, it is better to accept traditional beliefs.
10. More importance should be attached to traditional beliefs than the new discoveries of science.

APPENDIX-4

SCIENCE MOTIVATION QUESTIONNAIRE II (SMQ-II)

In order to better understand what you think and how you feel about your science courses, please respond to each of the following statements from the perspective of "When I am in a science course…"

Statements	Never 0	Rarely 1	Sometimes 2	Often 3	Always 4
01. The science I learn is relevant to my life.					
02. I like to do better than other students on science tests.					
03. Learning science is interesting.					
04. Getting a good science grade is important to me.					
05. I put enough effort into learning science.					
06. I use strategies to learn science well.					
07. Learning science will help me get a good job.					
08. It is important that I get an "A" in science.					
09. I am confident I will do well on science tests.					
10. Knowing science will give me a career advantage.					
11. I spend a lot of time learning science.					
12. Learning science makes my life more meaningful.					
13. Understanding science will benefit me in my career.					
14. I am confident I will do well on science labs and projects.					
15. I believe I can master science knowledge and skills.					
16. I prepare well for science tests and labs.					
17. I am curious about discoveries in science.					
18. I believe I can earn a grade of "A" in science.					
19. I enjoy learning science.					
20. I think about the grade I will get in science.					
21. I am sure I can understand science.					
22. I study hard to learn science.					
23. My career will involve science.					
24. Scoring high on science tests and labs matters to me.					
25. I will use science problem-solving skills in my career.					

Note. The SMQ-II is copyrighted and registered. Go to **http://www.coe.uga.edu/smq/** for permission and directions to use it and its discipline-specific versions such as the Biology Motivation Questionnaire II (BMQ-II), Chemistry Motivation Questionnaire II (CMQ-II), and Physics Motivation Questionnaire II (PMQ-II) in which the words *biology*, *chemistry*, and *physics* are respectively substituted for the word *science*. Versions in other languages are also available.

APPENDIX-5

Dimension wise Splitting of Science Motivation Questionnaire II (SMQ II)

Factor 1: Intrinsic Motivation

1. Learning science is interesting.
2. I am curious about discoveries in science.
3. The science I learn is relevant to my life.
4. Learning science makes my life more meaningful.
5. I enjoy learning science.

Factor 2: Career Motivation

1. Learning science will help me get a good job.
2. Understanding science will benefit me in my career.
3. Knowing science will give me a career advantage.
4. I will use science problem-solving skills in my career.
5. My career will involve science.

Factor 3: Self- Determination

1. I study hard to learn science.
2. I prepare well for science tests and labs.
3. I put enough effort into learning science.
4. I spend a lot of time learning science.
5. I use strategies to learn science well.

Factor 4: Self- Efficacy

1. I believe I can earn a grade of “A” in science.
2. I am confident I will do well on science tests.
3. I believe I can master science knowledge and skills.
4. I am sure I can understand science.
5. I am confident I will do well on science labs and projects.

Factor 5: Grade Motivation

1. Scoring high on science tests and labs matters to me.
2. It is important that I get an "A" in science.
3. I think about the grade I will get in science.
4. Getting a good science grade is important to me.
5. I like to do better than other students on science tests.

APPENDIX-6

SCIENCE ANXIETY QUESTIONNAIRE
CZERNIAK and CHIARELOTT 1984

QUESTIONNAIRE

GRADE_____ FEMALE_____ MALE_____

The statements in this questionnaire are about science and science related experiences. For each statement, place an X on the line under the column that best describes how you would feel in that situation.

EXAMPLE:	Very Calm	Fairly Calm	Neutral	A Little Nervous	Very Nervous
Giving an oral book report.	_____	_____	_____	X	_____

(If giving an oral book report makes you nervous only a little amount, you would place an X on "A Little Nervous".)

	Very Calm	Fairly Calm	Neutral	A Little Nervous	Very Nervous
1. Starting science class.	_____	_____	_____	_____	_____
2. Having someone watch you do an experiment.	_____	_____	_____	_____	_____
3. Studying for a test in science.	_____	_____	_____	_____	_____
4. Planning a well-balanced meal to pack for lunch.	_____	_____	_____	_____	_____
5. Looking through the science book for your class.	_____	_____	_____	_____	_____
6. Mixing boiling water and ice to get water to reach the right temperature for an experiment.	_____	_____	_____	_____	_____
7. Studying for a test about the earth.	_____	_____	_____	_____	_____
8. Visiting a science museum.	_____	_____	_____	_____	_____
9. Being asked to explain a topic in science class.	_____	_____	_____	_____	_____
10. Using a thermometer to measure the temperature of water in an experiment.	_____	_____	_____	_____	_____
11. Taking a science test.	_____	_____	_____	_____	_____

	Very Calm	Fairly Calm	Neutral	A Little Nervous	Very Nervous
2. Measuring a cup of sugar to make cookies.					
3. Being called on in science class.					
4. Showing a classmate the results of your experiment.					
5. Taking a quiz in science.					
6. Cooling down a hot sink of water to the right temperature to be able to wash dishes.					
7. Asking the teacher a question in science class.					
8. Weighing something to use in an experiment.					
9. Memorizing the names of parts of the body for a science test.					
10. Lighting a grill for a barbeque.					
11. Doing a science home-work assignment.					
12. Figuring out how to connect a light bulb in an electrical experiment.					
13. Memorizing the names of things in space for a science test.					
14. Following the steps to build a model.					

	Very Calm	Fairly Calm	Neutral	A Little Nervous	Very Nervous
25. Listening to the teacher in science class.					
26. Adding a small amount of powder to a liquid in an experiment.					
27. Showing your parents your last science test.					
28. Reading a science magazine and having a friend ask you about it.					
29. Writing a report for science class.					
30. Following directions to do an experiment.					
31. Showing your parents your science grade on your report card.					
32. Focusing a camera to take a picture of some friends.					
33. Having a classmate listen to your science report.					
34. Focusing a microscope.					
35. Thinking about a test in science one day before you are to take it.					
36. Replacing a dead bulb in a lamp.					
37. Reading a chapter in your science book and being asked to explain it.					

	Very Calm	Fairly Calm	Neutral	A Little Nervous	Very Nervous
38. Blowing up a balloon to the right size for a science experiment on air.					
39. Thinking about a science test one hour before you are to take it.					
40. Filling your bicycle tire with the right amount of air.					

APPENDIX-7

Dimension wise Splitting of Adapted Science Anxiety Questionnaire

Dimension 1: Fear of Testing

1. Feeling before taking a science test.
2. Taking up a science quiz.
3. A day before studying for final exams of science.
4. When called for viva-voce on the day of practical exams.
5. When asked to demonstrate experiment individually.

Dimension 2: Application of Science

1. Weighing small quantities of chemicals for experiment.
2. Focusing the lens of the microscope.
3. Reading the temperature on the thermometer.
4. Connecting a light bulb in an electrical experiment.
5. Determining the pH of drinking water and different solutions by the pH test paper.

Dimension 3: Performance in Front of Others

1. Having your science teacher watch you experiment in lab.
2. Solving a science problem on blackboard in the class.
3. Asking a question to a science expert visiting school as a class representative.
4. Speaking as a team leader in science competitions.
5. Demonstrating the working principle of a model in science exhibition.

Dimension 4: Teachers' Behavior, Teaching Style and Teaching Environment

1. Thinking of personality of your science teacher.
2. On being cautioned by science teacher to prepare hard for test.
3. Entering the science laboratory.
4. Approaching your science teacher for help.
5. Complex explanations in science lessons.

Dimension 5: Content Mastery

1. When asked to write the definition of a scientific concept in your own words.
2. Being asked to explain a studied concept to a junior.
3. Presenting your finding of experiment to the teacher.
4. Thinking of formulas and mathematical equations in science.
5. Learning about abstract concepts in science.

Dimension 6: Parent's Expectation

1. Constant reminders from parents to get best grade in science subject.
2. While you are compared with your friends doing well in science by your parents.
3. On being constantly compared with your sibling doing well in science by your parents.
4. Showing the test scores in science to your parents.
5. Knowledge of parent's high expectation to do well in science.

APPENDIX-8

Adapted Science Anxiety Questionnaire (Used for Data Collection)

Instructions for Students:

The statements given below are about science subject and science related experiences. For each statement choose the option which best describes about the way you feel about it. The options are **Very Relaxed, Fairly Relaxed, Neutral, A little Tensed, Very Tensed.**

For Example

When you are asked question by your science teacher you feel,……..“Very Tensed”

Sl. No.	Statements	Very Relaxed	Relaxed	Neutral	A Little Tensed	Very Tensed
1.	Feeling before taking a science test.					
2.	When asked to demonstrate experiment individually.					
3.	Focusing the lens of the microscope.					
4.	Having your science teacher watch you experiment in lab.					
5.	Solving a science problem on blackboard in the class.					
6.	Asking a question to a science expert visiting school as a class representative.					
7.	Approaching your science teacher for help.					
8.	Being asked to explain a studied concept to a junior.					
9.	On being constantly compared with your sibling doing well in science by your parents.					
10.	Presenting your finding of experiment to the teacher.					
11.	Showing the test scores in science to your parents.					
12.	Knowledge of parent’s high expectation to do well in science.					
13.	Connecting a light bulb in an electrical experiment.					
14.	On being cautioned by science teacher to prepare hard for test.					
15.	Entering the science laboratory.					

16.	**Complex explanations in science lessons.**					
17.	**Thinking of formulas and mathematical equations in science.**					
18.	**Learning about abstract concepts in science.**					
19.	**Constant reminders from parents to get best grade in science subject.**					
20.	**Taking up a science quiz.**					
21.	**When called for viva-voce on the day of practical exams.**					
22.	**A day before studying for final exams of science.**					
23.	**Reading the temperature on the thermometer.**					
24.	**Weighing small quantities of chemicals for experiment.**					
25.	**Demonstrating the working principle of a model in science exhibition.**					
26.	**Speaking as a team leader in science competitions.**					
27.	**Thinking of personality of your science teacher.**					
28.	**Determining the pH of drinking water and different solutions by the pH test paper.**					
29.	**When asked to write the definition of a scientific concept in your own words.**					
30.	**While you are compared with your friends doing well in science by your parents.**					

APPENDIX-9
Emotional Stability Scale (ESS)

First Draft

Instructions for Students:

Following are statements relating to different situations in your day to day life and your response to them. Please try to choose the best possible options out of the given alternatives (**Often, Sometime, Rarely**) describing your reactions to the particular situation.

For example,

There are times when I feel very blue and don't know what to do. …… Often

Sl. No.	Statements	Often	Sometime	Rarely
1.	**I feel excited when I am given responsibility of a new assignment.**			
2.	**I feel butterflies in my stomach when I am about to see the question paper in examination hall.**			
3.	**I find it difficult to concentrate in reading textbook when my friends are talking around.**			
4.	**I find it difficult to get started with my studies.**			
5.	**I am able to control my emotions in public gathering.**			
6.	**My friends find it easy to share their personal secrets with me.**			
7.	**I make it a point to finish my work in time.**			
8.	**I feel offended if my suggestions are not included in any decision**			
9.	**I easily get carried away in any social discussions taking it very personally.**			
10.	**I find it easy to go by the decision taken by the group collectively.**			
11.	**I am adjustable to a sudden change if it is necessary.**			
12.	**In a contest it is easy to hide my desire to win.**			
13.	**It is easy for me to identify with feelings of others.**			
14.	**I easily get irritated if I have to handle multiple**			

	tasks at a time.			
15.	**It is easy for me take decisions for myself.**			
16.	**If I am asked to sit and work with a new person I can easily start off.**			
17.	**It is easy for me to forget a thing I don't want to remember.**			
18.	**I don't allow myself to open up unless it is very difficult to do so.**			
19.	**If my favourite team losses a match I start grumbling about the players.**			
20.	**I make it a point to listen to others before responding.**			
21.	**I can easily initiate conversation with a new member in a group.**			
22.	**It is easy for me to follow discipline even if others are not following.**			
23.	**I prefer working silently.**			
24.	**I don't give up trying just if I failed in first attempt.**			
25.	**I undergo sudden change of mood which I am not able to control.**			
26.	**I envy my friends if they are given social recognition.**			
27.	**I can easily wait for my turn to come when I am in any queue.**			
28.	**It is hard for me to get rid of thinking about the worst that can happen to me.**			
29.	**I get irritated if others want me to change any aspect of my behaviour.**			
30.	**I never hesitate to learn from my mistakes.**			

APPENDIX-10
Emotional Stability Scale (ESS)

Final Scale

(Used for Data Collection)

Instructions for Students:

Following are statements relating to different situations in your day to day life and your response to them. Please try to choose the best possible options out of the given alternatives (**Often, Sometime, Rarely**) describing your reactions to the particular situation.

For example,

There are times when I feel very blue and don't know what to do. …… Often

Sl. No.	Statements	Often	Sometime	Rarely
1.	**I feel excited when I am given responsibility of a new assignment.**			
2.	**I feel butterflies in my stomach when I am about to see the question paper in examination hall.**			
3.	**I find it difficult to get started with my studies.**			
4.	**I am able to control my emotions in public gathering.**			
5.	**My friends find it easy to share their personal secrets with me.**			
6.	**I make it a point to finish my work in time.**			
7.	**I feel offended if my suggestions are not included in any decision**			
8.	**I easily get carried away in any social discussions taking it very personally.**			
9.	**I find it easy to go by the decision taken by the group collectively.**			
10.	**I am adjustable to a sudden change if it is necessary.**			
11.	**In a contest it is easy to hide my desire to win.**			
12.	**It is easy for me to identify with feelings of others.**			
13.	**I easily get irritated if I have to handle multiple tasks at a time.**			
14.	**It is easy for me to take decisions for myself.**			

15.	**If I am asked to sit and work with a new person I can easily start off.**			
16.	**I don't allow myself to open up unless it is very difficult to do so.**			
17.	**If my favourite team losses a match I start grumbling about the players.**			
18.	**I make it a point to listen to others before responding.**			
19.	**I can easily initiate conversation with a new member in a group.**			
20.	**It is easy for me to follow discipline even if others are not following.**			
21.	**I prefer working silently.**			
22.	**I don't give up trying just if I failed in first attempt.**			
23.	**I undergo sudden change of mood which I am not able to control.**			
24.	**I envy my friends if they are given social recognition.**			
25.	**I can easily wait for my turn to come when I am in any queue.**			
26.	**I get irritated if others want me to change any aspect of my behaviour.**			
27.	**I never hesitate to learn from my mistakes.**			

APPENDIX-11

Experts' Responses on Science Anxiety Questionnaire on Google Form

Timestamp	Expert's Name	Feeling before taking a science test.	Taking up a science quiz.	A day before studying for final exams of science.	When called for viva-voce on the day of practical exams.	When asked to demonstrate experiment individually.	Weighing small quantities of chemicals for experiment.	Reading the temperature on the thermometer.	Focusing the lens of the microscope.	Connecting a light bulb in an electrical experiment.	Determining the pH of drinking water and different solutions by the pH test paper.	Having your science teacher watch you experiment in lab.	Solving a science problem on blackboard in the class.	Demonstrating the working principle of a model in science exhibition.	Asking a question to a science expert visiting school as a class representative.	Speaking as a team leader in science competitions.	Thinking of personality of your science teacher.	Approaching your science teacher for help.	On being cautioned by science teacher to prepare hard for test.	Complex explanations in science lessons.	Entering the science laboratory.	Being asked to explain a studied concept to a junior.	When asked to write the definition of a scientific concept in your own words.	Thinking of formulas and mathematical equations in science.	Learning about abstract concepts in science.	Presenting your finding of experiment to the teacher.	Constant reminders from parents to get best grade in science subject.	Showing the test scores in science to your parents.	While you are compared with your friends doing well in science by your parents.	Knowledge of parent's high expectation to do well in science.	On being constantly compared with your sibling doing well in science by your parents.
########	P.K.Gupta	Highly Valid	Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Valid	Valid	Valid	Highly Valid	Valid	Highly Valid	Low Validity	Valid	Low Validity	Valid	Valid	Valid	Highly Valid	Highly Valid	Highly Valid	Valid	Highly Valid	Highly Valid	Valid	Highly Valid	Highly Valid
########	Dr. H.Malsawmi	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Low Validity	Highly Valid	Valid	Highly Valid	Highly Valid	Valid	Highly Valid	Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Valid
########	Prof. B.B.Mishra	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Valid	Valid	Valid	Valid	Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Valid	Highly Valid	Highly Valid	Highly Valid	Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid
########	Prof. Anjali Bajpai	Valid	Low Validity	Valid	Highly Valid	Valid	Low Validity	Valid	Valid	Highly Valid	Valid			Highly Valid	Highly Valid	Highly Valid	Valid	Valid	Valid	No Validity	Valid	Valid	Valid	Valid	Valid	Valid	Highly Valid	Highly Valid	Highly Valid	Low Validity	Highly Valid

APPENDIX-12

Experts' Responses on Emotional Stability Scale on Google Form

Timestamp	Expert's Name:	I feel excited when I am given responsibility of a new assignment.	I feel butterflies in my stomach when I am about to see the question paper in examination hall.	I find it difficult to concentrate in reading textbook when my friends are talking around.	I find it difficult to get started with my studies.	I am able to control my emotions in public gathering.	My friends find it easy to share their personal secrets with me.	I make it a point to finish my work in time.	I feel offended if my suggestions are not included in any decision	I easily get carried away in any social discussions taking it very personally.	I find it easy to go by the decision taken by the group collectively.	I am adjustable to a sudden change if it is necessary.	In a contest it is easy to hide my desire to win.	It is easy for me to identify with feelings of others.	I easily get irritated if I have to handle multiple tasks at a time.	It is easy for me take decisions for myself.	If I am asked to sit and work with a new person I can easily start off.	It is easy for me to forget a thing I don't want to remember.	I don't allow myself to open up unless it is very difficult to do so.	If my favorite team losses a match I start grumbling about the players.	I make it a point to listen to others before responding.	I can easily initiate conversation with a new member in a group.	It is easy for me to follow discipline even if others are not following.	I prefer working silently.	I don't give up trying just if I failed in first attempt.	I undergo sudden change of mood which I am not able to control.	I envy my friends if they are given social recognition.	I can easily wait for my turn to come when I am in any queue.	It is hard for me to get rid of thinking about the worst that can happen to me.	I get irritated if others want me to change any aspect of my behavior.	I never hesitate to learn from my mistakes.
########		Valid	Valid	Valid	Valid	Highly Valid	Valid	Valid	Valid	Valid	Valid	Valid	Low Validity	Low Validity	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Valid	Highly Valid	Highly Valid	Valid	Highly Valid	Valid	Valid	Valid	Highly Valid	Highly Valid	Valid	Highly Valid
########	P.K.Gupta	Valid	Valid	Valid	Valid	Highly Valid	Valid	Highly Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Highly Valid	Valid	Highly Valid	Valid	Valid	Highly Valid	Valid	Valid	Highly Valid	Valid	Valid	Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid
########	Devraj Goel	Highly Valid	No Validity	Valid	Low Validity	Highly Valid	Highly Valid	Highly Valid	Highly Valid	No Validity	Valid	Highly Valid	Valid	Highly Valid	No Validity	Highly Valid	Valid	Low Validity	Highly Valid	Low Validity	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Low Validity	No Validity	Highly Valid	Highly Valid	Low Validity	Highly Valid
########	Dr.M.A.Sudhir	Highly Valid	No Validity	No Validity	Low Validity	Valid	Valid	Highly Valid	No Validity	Low Validity	Highly Valid	Highly Valid	Valid	Valid	No Validity	Valid	Valid	Valid	Valid	Low Validity	Highly Valid	Highly Valid	Valid	Valid	No Validity	No Validity	No Validity	Valid	Low Validity	No Validity	Valid
########	Dr. H.Malsawmi	Highly Valid	Highly Valid	Low Validity	No Validity	Highly Valid	Valid	Low Validity	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Low Validity	Highly Valid	Valid	Low Validity	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Valid	Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Valid	Highly Valid	Highly Valid
########	Prof. B.B.Mishra	Highly Valid	Highly Valid	Highly Valid	Low Validity	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Low Validity	Highly Valid	Highly Valid	Highly Valid	Highly Valid	Highly Valid
########	Prof. Anjali Bajpai	Highly Valid	Highly Valid	Valid	Low Validity	Valid	Valid	Valid	Valid	Valid	Valid				Highly Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid	Valid

APPENDIX-13

PARTICULARS OF THE CANDIDATE

NAME OF THE CANDIDATE : NITU KAUR

DEGREE : Ph.D.

DEPARTMENT : EDUCATION

TITLE : Impact of Selected Affective Variables on Achievement in Science of Secondary School Students in Aizawl District of Mizoram

DATE OF ADMISSION : 7th August, 2014

COURSE WORK SESSION : August-December 2014

APPROVAL OF RESERCH PROPOSAL

1. BOS IN EDUCATION : 14th October, 2015
2. SCHOOL BOARD : 9th November, 2015

REGISTRATION NO. :Ph.D. Regd. No.MZU/Ph.D./809 of 9.11.2015

EXTENSION(if any) : NA

(PROF. B. B. MISHRA)

Head
Department of Education

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How much Scientifically Tempered we are? A question for introspection

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Abstract

This article is an attempt to conceptualize the affective trait of scientific temper in relation to nature of science (NOS). By affective we refer to the one's affect such as emotions, feelings, moods and attitudes associated with various actions one perform. The trait of scientific temper is affective in nature because its manifestation involves a constant conversation with one's self. One's temper is very much influenced by his/her dominant feelings, likes and dislikes and emotional inclination. Scientific temper is defined as a frame of mind that accepts truth in its real form without subjecting it to any kind of influence. It is observed that some individuals possess a high degree of scientific temper and some are relatively less scientifically tempered. In both the categories it holds a direct bearing to their understanding of NOS. NOS is a misinterpreted concept in school science that leads to misconceptions about science within students which persists in their later lives also. It is a varying thought process as different individuals seem to place themselves in different positions in their perceptions about NOS. A better understanding of NOS in an individual helps him/her to relate science more meaningfully in their lives. Thus the perception of NOS seems to have an impact on the trait of scientific temper. Scientific temper enables a person in making unbiased judgments and informed decisions. It holds a great significance in the decision-making process of an individual in day to day affairs. It can be said in a nutshell that societies preaching the real nature of science through the process of schooling seems to be more scientifically tempered in their outlook. However, the trait of scientific temper is operational in both scientific and non-scientific setting. In fact being scientifically tempered in our social settings has a high return value in terms of combating with various social problems. *Keywords:* Scientific Temper, Nature of Science (NOS)

The Coining of the Terminology of Scientific Temper

The post independent India under the leadership of its first Prime Minister Jawaharlal Nehru got a firm footing in the sphere of Science and Technology. The Nehruvian vision was to develop the nation by rejuvenating it through the spirit of 'Scientific Temper', a term coined by him in his book 'Discovery of India' (1946). He wrote in his book that, although science has been dominating in the western world, west is still far from having developed the real temper of science whereas India, in spite of her less triumph in the sciences, has the advantage of traditions encouraging fearless search for truth, respecting the solidarity of man, the divinity of everything living, free and co-operative development of the individual and the species, ever to greater freedom and higher stages of human growth (Nehru, 1946, pp.514-516). His conclusion was a direct outcome of two world wars fought in the recent past that ashamed humanity. It was a timely plea to

the world leaders, politicians, scientists, citizens of the times to identify the much needed notion of 'scientific temper'. In fact, India included 'scientific temper' in her constitution through 42nd constitutional amendment, 1976. It was introduced as a sub clause of article 51-A (h) of Indian constitution 1949, as one of the fundamental duties to be performed by Indian citizens which states, '*to develop the scientific temper, humanism and the spirit of inquiry and reform'*.

After the death of Nehru, the legacy of scientific temper was taken forth by the Nehru centre, Bombay which has been organizing Nehru memorial lecture series since 1966. After being framed as a fundamental duty of Indian citizen, the notion of scientific temper again came in lime light July 1981, when some group of people, mainly from the academia at Nehru centre in Bombay issued an historical statement on scientific temper. This historical event invited a lot of debate all over the country and since then a lot of thinking has been again poured into this forgotten notion.

What is being Scientifically Tempered?

The term temperament is distinctly associated with G.W. Allport, who is regarded as the founder of personality psychology. Temperament refers to the characteristic phenomena of an individual's emotional nature, including his susceptibility to emotional stimulation, his customary strength and speed of response, the quality of his prevailing mood and all the peculiarities of fluctuation and intensity of mood, these phenomena being regarded as dependent upon constitutional make-up and therefore largely hereditary in origin. (Allport, 1961, p. 34). Goldsmith and Campos (1986) defines 'temperament as individual differences in emotionality'. McCrae et.al (2000) states that there is no hard and fast distinction between temperament and personality and there are both empirical and conceptual links between child temperaments and adult personality traits. Review of literature suggests that the term temperament and personality are used interchangeably (Strelau, 1987).

Although the aspects of behavior, thought, and affect are widely acknowledged to be reflected in temperament, the emphasis has more often been on affective elements, and on biologically based traits (Saucier & Simonds, 2006)

It is evident from the above definitions that temperament is an affective construct which deals with emotionality and has a direct or indirect linkage to one's personality. It could be a possible reason for Nehru to pick the term 'temper' from the psychological construct of 'temperament'. Nehru associated temper with science synthesizing a typical trait associated with science and being a scientist. It is a required commitment and inclination within a doer of science in order to understand and apply science in both academic and societal level.

A Statement on Scientific Temper prepared by a group of scholars and issued on behalf of the Nehru Centre, Bombay, in July 1981, mentions that Scientific Temper involves the acceptance, amongst others, of the following premises: (a) that the method of science provides a viable method of acquiring knowledge; (b) that the human problems can be understood and solved in terms of knowledge gained through the application of the method of science; (c) that the fullest use of the method of science in everyday life and in every aspect of human endeavour from ethics to politics and economics is essential for ensuring human survival and progress; and (d) that one should accept knowledge gained

through the application of the method of science as the closest approximation of truth at that time and question what is incompatible with such knowledge; and (e) that one should from time to time re-examine the basic foundations of contemporary knowledge.

Narlikar (1993) emphasized that scientific temper is the real need of the hour which guides man to rational recourses whenever there is conflict between science and tradition. One neither has to be dazzled by miracles of science nor blinded by overpowering traditions. Scientific temper is that self-correcting tendency of rational beings that helps him/her to harmonize between needs and desires. He said there are three fundamental processes operating in science which are Experiment (E), Observation (O) and Deduction (D) that keeps science going and scientifically tempered person believes in the EOD system of testing and verifying knowledge.

According to Dhar (2009), scientific temper, or scientific attitude is characterized by following traits: a)Healthy skepticism, b)Universalism, c)Freedom from prejudice or bias, d) Objectivity, e)Open mindedness and humility, f) Willingness to suspend judgment without sufficient evidence, g) Rationality, h)Perseverance - positive approach to failure.

According to Palampur declaration (2011) scientific temper is defined as a world-view, an outlook, enabling ordinary citizens to choose efficient and reliable knowledge while making decisions in their individual and social domains; it is not the content or extent of knowledge base of one or other domain of scientific corpus that a citizen acquires, but rather the pursuit of rational enquiry, which is the hallmark of scientific temper.

Mahanti (2013) gives a historical tracing of the concept of scientific temper in our country. He reported that although the termed was coined and used for the first time by our first Prime Minister Pt. Jawaharlal Nehru, the existence of the notion can be traced back to Gautama Buddha in Indian traditions and to social reformers like Raja Rammohun Roy, Rajendralal Mitra and Prafulla Chandra Ray. He also reports that it was our first prime minister who greatly contributed for upholding of this nation under which country's development could gain a momentum. Nehru's effort led to the adoption of Scientific Policy Resolution (SPR) of 1958 by Indian parliament which prioritized the growth of science and technology.

Gopichandran (2013) tried to emphasize on the need of the hour for nation, especially in context of launch of 12th five year plan, i.e. to instill the trait of scientific temper both in masses and educational institutions. He further said that students at all levels of learning including higher education and research should be oriented to principles of science and scientific thinking, wherein such aspects as open-endedness of insights, heuristics, emerging frontiers of knowledge based on newer and better application of tools/techniques and limits and limitations of systems of investigations and insights are suitably highlighted. It is equally important to infuse such human values as respect for knowledge systems and the spread and depth of knowledge consolidation that does not necessarily reveal the founding principles, precautionary principles and common good.

Saxena (2014) tried to pinpoint the misconception about scientific temperament (temper) within the layman because of ignorance. He suggests that educating the young in order to imbibe in them an argumentative approach to test and accept things is perhaps the only way to develop scientific temper in society.

Raza (2015) tried to compare the hazy or nebulous notion of scientific temper with the European enlightenment. He argued that scientific temper not only confines itself with areas of human cognition and action but it goes beyond the boundaries of science and extents in the realms of extra-science as well. The struggle of creating a scientifically tempered society is a collective endeavour to be strived by one and all and scientific awareness is the prerequisite for it. He cited evidence where increase in scientific information in society does not guarantees the reduction of extra-scientific beliefs. Both tend to coexist with their contrasts as long as they are not in the way of each other which is a very doubtful situation for scientific temper.

Thus in summation it can said that being scientific tempered means to accept the truth in its real form without subjecting it to any kind of influence. It is a temper of a free man (Nehru, 1946, pp.512). It is man's capability in dealing with both scientific and the non-scientific issues in the society.

The Real Nature of Science

The Nature of Science (NOS) is never understood especially in philosophical perspective in traditional school science. It is the most abstract domain of science education and hence most little dealt. NOS is an unfamiliar and alien domain in Indian scenario. NOS is a multifaceted concept that including the aspects of history, sociology and philosophy of science and has been defined variously as science epistemology, the characteristic of scientific knowledge and science as a way of knowing (Bell, 2008). Often it is misunderstood by the teachers and mis-communicated to the students leading to conceptual stigmas. This domain of science is poorly addressed in majority of curricular materials, and when it is addressed it is misrepresented (Bell, 2008). NOS acquaints student with kind of knowledge generated by the scientific community and characterize its generalizations and limitations both. The very basic NOS is that science cannot provide complete answer to all questions/problems (Eastwell, 2001). But often societies hold just an opposite assumption and have far-fetching expectations from science. Another common assumption about science is that everything which is imagined scientifically should find an experimental explanation in order to be part of scientific knowledge. But there are instances where only through imagination many probable solutions for a given problem were sought by a scientist, which was found to be absolutely valid when tested by someone else. A popular myth about NOS is that there is 'a universal scientific method' every time followed by scientists to derive scientific knowledge (Eastwell,2001; Bell,2008). This belief needs to be rectified. Whereas scientific method is most followed method in deriving scientific knowledge, there are still some parallel means like experience, imagination and intuition that may also work in order to reach certain conclusions.

The whole scientific enterprise is based on notion of 'tentativeness' which states that nothing in science can be treated as constant static truth rather it is dynamic truth. Scientific knowledge is a filtered authentic and stable piece of knowledge which is checked for its validity and reliability in multiple experimental settings. Replication of experimental setting is nothing but filtering the facts and nearing the truth. The degree of authenticity of this knowledge increases every time it is verified through truth filters. Scientific knowledge is some time subjective but its subjective nature can be translated

to objectivity by perseverance i.e. through repeated trials. Science seeks subjective clarification although it is objectively conceived. Science is not a solitary pursuit (Eastwell, 2001) rather a collective and cooperative endeavor and a valid scientific explanation may not be possible in a standalone platform. Science is value free but technology which is a companion to science is value laden. It is associated with some goodness or badness about it; and hence technology is not science (Wolpert, 2002). Technology makes scientific principles, theories, and laws workable and usable but science is far more than a technological enterprise. Perhaps in Indian educational setting treating science as technology is the biggest misconception about the nature of science held by students and teachers. NOS is not part of science curriculum in our country which leads to inadequate understanding about science within the school students. Students fail to utilize the scientific knowledge in their own lives because they are never exposed to the notion of NOS. The problem emerges because of lack of harmony in between scientific methods and process skills in science teaching. The science laboratories are often overloaded with miniature practical replicas of experiments having no time for discussing the kind of process skills required for doing science. This creates lot of confusion and tension in the minds of young learner who might find learning and doing science bit abstract. Students are taught what to explain but not how to explain, they are taught how to reach a particular conclusion through an observation but not what they can infer from observations and its background; students are taught about forward approach of experimenting and concluding and not much about backward approach of designing a new experiment based on permutations and combinations of available facts. This is how students are introduced to the NOS, at least till their secondary level of schooling in our country. This characterizes science as being abstract, hostile, difficult, serious, not fit for all, which is not the real nature of science. Bell (2008) highlighted the importance of science process skills in order to understand the nature of science. Science process skills can be taught to students right from their elementary science lessons, thus can become a potential tool in teaching the NOS. Doing science at any stage of schooling has a direct bearing to basic process skills like observing, measuring, classifying, inferring, communicating, prediction and higher order integrated process skills like hypothesizing, investigating, controlling, and experimentation. It thus has an indirect linkage with NOS. This leads to a thought that non-misinterpreted knowledge of NOS enables a student of science and even the non-science students to rightly relate scientific knowledge with their lives. The task of the teacher is to provide clarity against some popular myth about NOS. Students should be well aware about real nature of science, in absence of which they might not be able to understand the real essence of doing science.

The Relationship between being Scientifically Tempered and Understanding the Nature of Science (NOS)

An analysis of characteristics of scientific temper and nature of science suggest that there is some overlapping characterization. It is explained as follows:

It is believed that students ‘understanding of science’ as a ‘way of knowing’ is absolutely necessary if informed decisions are to be made regarding the scientifically based personal and societal issues that increasingly confront them; such decisions necessarily

involve careful evaluation of scientific claims by discerning connections among evidence, inferences, and conclusions(Zeidler et.al., 2004)

A popular myth about NOS states that everything can be proved using scientific method alone. Scientific method is an amalgamation of inductive and deductive method. There is debate in scientific community over the superiority of one over other. It is just like egg and chicken puzzle asking which came first. However, there is no fixed method but 'trial and error' method is the heart of any scientific expedition. Even in primitive times the discovery of fire or the invention of wheel was an outcome of trial and error. In both inductive and deductive methods there is commonality of evidence. 'Evidence' is observable by our senses and inferable through logic. Scientific temper can be equated to application of the scientific method based on logic and evidence (Palampur declaration, 2011). A scientifically tempered person therefore looks for evidences to judge any situation. He/she tries to evaluate things, situations and circumstances in the light of evidence. The history of science reveals both evolutionary and revolutionary changes where with new evidence and interpretation, old ideas are replaced or supplemented by others (National Science Teachers Association, USA, 2000). A scientifically tempered person similarly revolutionary in his ideology and is more open to a change. He/she resorts to trial and error frequently before coming to a conclusion.

A second point of overlap is provided by finding an answer to the question that should we rely on facts or methodology of doing science. NOS advocate the importance of process over content. Mere content which enables us to answer 'what' and not 'how' are misleading for students of science. According to Dewey (1916) understanding scientific method is more important than acquisition of scientific knowledge provides a support system to any person in taking scientific decisions. A scientifically tempered person tests the factual knowledge for its validity and does not simply believe on any propaganda or statement. He/she applies the process of sciences to derive meaningful conclusions. The open mindedness of a scientifically tempered person guides him/ her to perceive reality keeping space for required adjustments as and when required for accommodating whole truth than partial truths.

Thirdly, we feel that proper analysis of contexts are very important in any decision making process. Seeing things through the lens of context is an outcome of post-modern thought process which asks whether science is interdependent with or independent of cultural context. For e.g. there are instances in the history of science when some scientists never gave up their faith in a particular theory which they claimed to be true and tried to adhere to it. Such claims were rewarded much later for their truth, sometime even posthumously. Our immediate surroundings, contexts, frame of references are our first teachers. Our contexts shades our imagination and give rise to our ways of thinking. There is nothing wrong in being contextualized and the real NOS appreciate its significance. In recent times the local ecological knowledge and the tacit knowledge has been acknowledged for its benefits which is nothing but contextualized knowledge. Lack of rigidity in the attitude helps a scientifically tempered person to be more adaptive to changing times. He/she sees things in light of contexts and rely on holistic inferences and not single observation.

Finally, there is a central question, whether science is all about providing ideas which are workable or science is just a knowledge expedition, whether it is works or not is a matter outside its purview? Wolpert (2002) raised a similar question, whether scientists are for application of science? He answered this question by saying, this is neither possible nor should be expected from scientists. Scientists just search truth and in course of doing so some time through serendipity, or by curiosity some unexpected outcomes take place. A scientist cannot predict the future outcome of his discovery or invention. The real problem comes when a scientific finding is applied in public through technology, which inherently comes with ethical issues (Wolpert, 2002). The real nature of science is honest inquiry where a scientist is not held responsible for the unpredictable consequence of a scientific finding. The very nature of science is that it is not possible to predict what will be discovered or how these discoveries could be applied the most apt example being that of cloning (Wolpert, 2002).Science is neither good nor bad but it is its application which makes it good or bad. Man is a moral being and it is his decision making that decides the course of science. Wolpert (1992) defines 'openness' as one of the most characteristic features of science, along with allowance for controversy and public access to knowledge. Technology, by contrast, he presents as a style of thought that promotes secrecy and thrives in recipes and opaque (pre-scientific) procedures. Thus issue of morality and ethics is involved with every application of science made possible through the technological enterprise. Technology on one hand depends on science and on the other hand paves the path for future scientific endeavor. While science and technology do impact each other, basic scientific research is not directly concerned with practical outcomes, but rather with gaining an understanding of the natural world for its own sake (National Science Teachers Association, USA, 2000). Hence reliable scientific knowledge is value-free and has no moral or ethical concern. In light of this conception the nature of science is very unpredictable and a scientifically tempered person knows how to judge a scientific discovery or invention in the light of morality. For e.g. a person with such temper will surely choose to technologies which are environmental friendly such as biodegradable, pollution free, natural, cost effective and efficient. A very apt scenario of ignorance of scientific temper is presented through the plot of Gulf war where massive resources of oil fields in a gulf nation were destroyed by another nation just to win a battle, which was fought keeping the interests of total world population at stake. Natural resources are commonly shared inheritance of all the human beings in terms of economic equality, but sadly very few nations own the maximum resources of the world. There is a fine line difference between being intelligent and wise. This is very well explained by Sir Bertrand Russell, a great philosopher, mathematician, scientist and social reformer,

"We are in the middle of a race between human skills as to means and human folly as to ends…….Unless men increase in wisdom as much as in knowledge, increase of knowledge will be increase in sorrow."

A person with scientific temper knows that being realistic, providing unbiased reality, with no hidden agenda or component of secrecy is real NOS. He/she knows that sometime all the answers cannot be provided by instrumental approach of science. Scientific temper in people enables them to suspend judgment through accuracy in

thought and action. They need to know the situation through an independent unbiased perspective and then judge it. Being unbiased is a key trait of NOS and scientific temper both. The trait of scientific tempered highlights the natural tendencies of children but as they grow, the degree of its effectiveness tends to decrease owing to constant molding through school science which somehow has been the main vehicle to propagate myths about NOS. As a result students fail to distinguish between science and technology, they believe that there is one universal scientific method which is followed by all scientists and that the scientific truths are unchangeable. Knowledge of NOS enables a person to distinguish between science and technology which in turn helps him to take informed decisions on the acceptance or rejection of a technology. If we as science educators wish to cultivate future citizens and leaders who care, serve the community, and provide leadership for new generations, then we have a moral imperative to delve into the realm of virtue, character, and moral development (Zeidler et.al, 2004). There is a guiding value system in built in nature of science that helps citizens to take informed decisions. What is required out of the process of schooling that children should be introduced to real nature of science and safeguard them from popular myths held about NOS.

Conclusion

It will be a mistake to call an age a scientific age just on the basis of the accumulated mass of scientific knowledge. An age can be called as scientific when the problem of society can be faced and handled by men with scientific temper (Jahagirdar). Through its emancipatory nature, science liberates us from the bondages of superstitions, bridges the gap between different strata of society, and has the potential to solve all the problems of mankind. In contrast, the same science can be mishandled and made oppressive through politicization and power play. The benefits of science like modern medicine, means of comfort are not equally accessible to all. It leads to new plot of disparity. This plot is very nicely narrated in the words of Nehru, “To-day, in the world of politics and economics there is a search for power and yet when power is attained much else of value has gone. Political trickery and intrigue take the place of idealism, and cowardice and selfishness takes the place of disinterested courage.” (1946, pp. 560). The main question of concern in 21st century is how much scientifically tempered we are? Are we prepared to choose between right and wrong, just on the basis of our training in science or we need something more than that?

It is very evident that real nature of science enables a science student to better learning experiences in science. Also it is through knowledge of NOS students are able to identify themselves with science in holistic perspective through the lens of history, sociology and philosophy of science. They find it more convictional and adaptable in their daily affairs. A scientifically tempered person possesses a mind-set that uses scientific method as a way of problem solving in his/her day to day life. If he/she knows the NOS well, he or she can do more informed decision making. Such people are more rational in their approach. Societies preaching the real nature of science through the process of schooling seem to be more scientifically tempered in their outlook.

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IMPACT OF SELECTED AFFECTIVE VARIABLES ON ACHIEVEMENT IN SCIENCE OF SECONDARY SCHOOL STUDENTS IN AIZAWL DISTRICT OF MIZORAM

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