A COMPARATIVE STUDY OF COGNITIVE LEARNING STYLES AND ATTITUDE OF SCIENCE STUDENTS AT UNDERGRADUATE LEVEL

By

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NATIONAL UNIVERSITY OF MODERN LANGUAGES ISLAMABAD

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Farkhunda Rasheed Choudhary


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THESIS AND DEFENSE APPROVAL FORM

The undersigned certify that they have read the following thesis, examined the defense, are satisfied with the overall exam performance, and recommend the thesis to the Faculty of Social Sciences for acceptance:

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Candidate of Doctor of Philosophy at the National University of Modern Languages do hereby declare that the thesis (Titled) A Comparative Study Of Cognitive Learning Styles And Attitude of Science Students At Undergraduate Level submitted by me in partial fulfillment of MPhil/ PhD degree, is my original work, and has not been submitted or published earlier. I also solemnly declare that it shall not, in future, be submitted by me for obtaining any other degree from this or any other university or institution.

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ABSTRACT

Thesis Title: A Comparative Study of Cognitive Learning Styles and Attitude of Science Students at Undergraduate Level

Everyone has a distinct style of thinking and learning. Because of individual differences, the cognitive learning style of every individual is different. Cognition explains an individual's usual mode of perceiving, thinking, remembering, or solving problem. Cognitive learning style is typically explained as a personality aspect which influences values, social interaction, and attitude. Researches have revealed that cognitive learning styles and attitude are joint contributors to behavior. This study was designed to understand, identify and compare cognitive learning styles and science related attitude of undergraduate science students, to compare science related attitudes of science students with respect to cognitive learning styles, to find relationship of cognitive learning styles with science related attitude and academic achievement, to find relationship between science related attitude and academic achievement of undergraduate science students. The population of the study consisted of all undergraduate science students of basic sciences (physics, mathematics, and bio sciences), computer sciences, and engineering sciences (electrical and computer engineering) of public and private sector universities/Degree Awarding Institutes of Islamabad. For sample selection, stratified random sampling was used. The data was collected using demographic inventory, Hidden Figure Test (SHAPES) and convergent/divergent test. A self-developed science related attitude questionnaire was used to identify student’s science related attitude. The academic results of students were obtained from the respective universities/Degree awarding institutes. Descriptive and inferential statistics were used for data analysis. Frequency distribution, percentage, mean, and standard deviation were used for data analysis. The hypotheses were tested using Chi-Square and t-tests at 5 percent level of significance. Results were presented in tabular and graphical form. The findings revealed that Field-Dependent and convergent cognitive learning style have been found the most prevailing cognitive learning styles of science students at undergraduate level. Moreover the Field-Independent and divergent learners have more science related attitude and academic achievement than other learners. The findings also revealed that cognitive learning styles have positive relationship with science related attitude and academic achievement. It has been recommended that teachers must use varied teaching methods and provide academic and career guidance to the students so that they can be motivated to develop more positive science related attitude towards the study of science and may improve their academic achievement.
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<td>AIOU</td>
<td>Allama Iqbal Open University, Islamabad</td>
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<tr>
<td>BU</td>
<td>Bahria University, Islamabad</td>
</tr>
<tr>
<td>CIIT</td>
<td>COMSATS Institute of Information Technology, Islamabad</td>
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<td>FUUAIST</td>
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Dedicated to

MY IDEAL FATHER (LATE)

ABDUL RASHEED CHOUDHARY
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Farkhunda Rasheed Choudhary
CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Latest innovations in science and technology have influenced all aspects of our social and economic lives and have become essential requirements for the socioeconomic development in the world. Scientific theories, engineering solutions and technological innovations, have made scientific, technological, and engineering literacy significant. In this era, scientific gadgets have become indispensable for everyone. The basic knowledge of science and technology is required for the efficient and safe use of products of scientific gadgets. To live a better life, sufficient knowledge of science and attitude towards science is essential. Scientific, mathematical, technological, and engineering disciplines are also necessary for knowledgeable and informed individuals. Therefore, there is need for continuous scientific investigations in these disciplines (Pitafi and Farooq, 2012). This has necessitated serious consideration for science education.

The emphasis on science education differs from country to country. In the developing countries, “the practical use of science through technology has created the climate for ever increasing emphasis on the pursuit of science education. Whereas, in developing countries, education, research and technology as instruments for accelerating development should receive special attention in national planning” (Bilsel and Oral,1995). The major objective of education in the developing countries is to impart scientific knowledge. Therefore, the elementary curriculum of Pakistan focuses on the scientific knowledge (Ministry of Education, Government of Pakistan, 2006, National Curriculum for General Science).
The purpose of science education and contemporary science curriculum is to increase science-literate individuals (Kaya et al., 2012; American Association for the Advancement of Science, 1993). Science-literate individuals will be able to think critically, solve problems in a better way, and make informed decisions. Such individuals will become lifelong learners and maintain their curiosity about the world that surrounds them.

Basic science literacy and scientific ways of knowing such as analysis, observation based conclusions and experiments enables individuals to think rationally and to make sound decisions on the basis of scientific knowledge. Scientific literacy also enables the individuals to understand the nature of science and developments in science; comprehend the basic science concepts, laws, principles and theories, and make their appropriate use. Such individuals can use science processes for problem solving and decision making; recognize the relationship between science and technology as well as science and environment; and develop interests that make one’s life richer and more comfortable (Köseoğlu, Atasoy, Kavak, Akkuş, Budak, Tümay, Kadayıfçi & Taşdelen, 2003). In its most general sense, science literacy is a combination of science-related capabilities, attitudes, values, approaches, and knowledge. The effective science education can help to solve global problems (Van Eijck & Roth, 2007).

With the increased complexities of both science and the societies, there is need that curriculum developers must start highlighting complex problems as the most important considerations in planning for the twenty first century (Morrison & Lederman, 2003) and making individuals eligible for informed decisions. (Corrigan, Dillon, Richard & Gunstone, 2007 p.4).

The research and statistics on the student’s enrolment rate show that “relatively few students are interested in pursuing careers in scientific disciplines, although there are large variations between the countries” (Sjøberg & Schreiner, 2005). Interestingly, the countries where students have obtained higher achievements in science have a lesser percentage of students really concerned to pursue for science related careers. Moreover, it has been observed that in various countries of the world there is an enormous dropout rate of graduates at upper secondary level with
scientific orientation (OECD, 2008; Shukla, 2005). Therefore, societies are seriously required to increase scientific literacy and improve the provision of the scientists for tomorrow. It is possible not merely through quality instruction; extensive provision of opportunities and facilities of research for all the students but there is also need to improve the interest of students and motivate them to scientific careers.

The achievement of more scientific approach in science education is possible through improved understanding of the essential cognitive mechanisms (Reif, 2008). Various researchers have explored the ways the cognitive factors influence learning. Similarly, different cognitive theories have explained the phenomena of learning by emphasizing different aspects. Some cognitive theories focus on how complex learning proceeds from one level or stage to the next. Cognitive-developmental theories, such as those of Jean Piaget, Richard Skemp, and Jerome Bruner, propose levels of successively more complex intellectual understanding or conceptualization. Other cognitive theories describe learning by the functions or mechanisms that are involved. Information processing models compare learning to computer functions, and brain based theories explain learning in terms of how the brain receives, stores, and retrieves information. (Martin, 1998, p.56)

Because of “Piagetian Cognitive Psychology”, there is a paradigm shift in the research programmes of science education. That is why “Piagetian theory dominated science education research for about two decades” (Reif, 2008). It is notable, that Piagetian theory has become core to science education; therefore, not only individuals were categorized as concrete or formal etc., but concepts were also characterized in the similar ways for learning (Shayer & Adey, 1981).

The learning process of all individuals is different from one another. Most of the students are not aware of it because majority of them attend schools where teachers teach them in one manner and do not support them to learn their unique styles. Although teachers of traditional classes have particular way of teaching, several learners have their own learning style. The concept of “learning styles” is important in education. Some students work better alone because in order to absorb
the material, they need time. On the other hand, there are certain students who work better in groups. The group discussions stimulate their brains and they understand by discussions. These are cognitive learning styles of students which make them different from each other. That is why the learning of one individual is not the same as that of the other.

Generally, learning styles have been categorized in many ways. With the growing advancements in technology, now students have many other ways to learn. Online resources such as videos, lectures, demonstrations, animations, and simulations etc. have facilitated learners according to their unique learning style. Students have different learning styles for different subjects. Teaching and learning science becomes interesting and significant when both teachers and learners take active part in scientific quest. They begin with simple ideas and then these ideas/concepts compound and form new and complex ideas. All the ideas of learners are valuable because they have the potential for learners to become better decision makers, consumers, and problem solvers.

Educators and cognitive psychologists have long been concerned about understanding of individual differences in cognition and their effect on instruction and learning. Numerous researches have suggested that learners with different cognitive styles process the information and solve the problems in different manners (Alamolhodaei, 2001; Ansburg, 2000; DeYoung, Flanders, Peterson, 2008; Al-Naeme, 1991; Mienaltowski, 2011). Consequently, cognitive styles facilitate in predicting how individuals process the information (Messick 1976a,b; Witkin et al. 1974; Witkin & Goodenough, 1980).

There are several streams of work contributing to the development of cognitive style (Zaman, 2006). One type of cognitive style may contribute to more effective learning in one discipline but may it be unfavourable in another discipline. In the views of Saracho (1998a), “a student with an analytic cognitive style may succeed in a situation requiring analytical skills whereas; a student with a global cognitive style may fail in the same situation”.

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The mostly used dimensions of cognitive style in education are Field-Dependent/Field-Independent (F.D/F.I) and Convergent/Divergent (CON/DIV). Field-Dependency/Field-Independency identify “an individual’s mode of perceiving, thinking, problem solving and remembering”. The research of Witkin et al. (1971), certainly, facilitated in building the field dependency theory to significantly separate people with one factor from the total visual field (Altun & Cakan, 2006). Field-Dependency/Field-Independency defines the individual’s dependency in a perceptual field while analyzing a structure or a form of that field. Field-Independent (F.I) individual can extract an element from the surrounding field and work out problems that have a vital component out of the content. In contrast, field-dependent (F.D) learners depend on the organization of a field as a whole; such learners maintain a global perspective as they deal with problems, while F.I learners maintain an analytical perspective (Goodenough, 1976; Saracho, 1998b; Witkin, 1976; Witkin, Moore et al. 1975; Witkin & Goodenough, 1980).

Similar to Field-Dependent/Field-Independent cognitive learning style, the Convergent and Divergent styles have also been studied by several researchers (Getzels and Jackson 1962; Guilford, 1967; Hudson, 1966). According to them, convergent/ divergent dimension deals with a type of thinking that is associated with problem solving strategies. The individuals usually cope with a problem or task of thinking in a way, which is either exploratory or open-ended; or highly focused or close-ended. When a person is more capable than others of elaborating the way to an answer and is skillful in giving a variety of answers to everyday questions, that person is called a divergent thinker. On the other hand, such individuals who use a single way to describe facts and they are not so skillful in giving a variety of answers to everyday life questions, may be called convergent thinkers.

The researchers (Lee, Kim, and Lee, 1996) as cited by Altun and Cakan (2006) have described cognitive learning styles and attitudes as joint contributors to behaviour. In views of Koballa (1989), although teachers understand the importance of student’s feelings regarding science courses and subjects; however, they put less importance on the “affective objectives”. The reason for frequently ignoring
affective domain is that the teachers face difficulty in devising such strategies which may be helpful in developing positive attitudes of students and keep a record of their development.

Attitude is generally defined as a tendency to respond favourably or unfavourably towards things, ideas, places, people, places, or events. Now a days attention to the student’s science related attitude has increased. In the western countries, the alarming decline in the science enrolments at the secondary and post-secondary levels and student’s disrespect for school science, and the promise of innovative research methods [associated with physiological expression] have provoked improved interest regarding science related attitude research (Osborne, Simon, & Collins, 2003).

The science related attitude has influenced learner’s choices for selecting different subjects, learner’s interest, and academic achievement in the scientific knowledge. Usually attitude is considered as the “degree of positive or negative effect”. Positive or favourable science related attitude facilitates the learning of subjects while a negative science related attitude results in poor learning and achievement. For that reason, one of the foremost areas of research interest for science educators is to know how students' attitude affects the learning of science subjects (Khine and Saleh, 2011). Therefore, Shah & Mahmood (2011) emphasized that “the endorsement of a positive science related attitude towards science has remained one of an important aim of the curriculum at school level (Aiken & Aiken, 1969; Koballa, 1988; Laforgia, 1988)”. The development in science education accounts several efforts in measuring attitudes and determining the correlations between behaviour, gender equity, career achievements, career ambitions, and cultural disposition. Several researchers revealed that “attitudes can be learned and teachers can encourage students to like science subjects through persuasion”. However, some believe that “science related attitude is situated in context and has much to do with upbringing and environment”. Therefore, the critical role of science related attitude has been very well recognized in the advancement of science
education, especially in the designing of curriculum, selecting effective pedagogies and nurturing learners.

Recognizing the significance of cognitive science and need to maintain positive science related attitude of students and make them motivated, the present study was designed to investigate the cognitive learning styles and science related attitude of those students who have opted undergraduate science programmes for higher studies after completing Higher Secondary School Certificate (HSSC) education.

Pakistan is a developing country. Science education is essential for its continuous development and to deal with the current and future challenges. Therefore, there is need of substantial number of scientists in disciplines like industry, agriculture, medicine, engineering, and research institutes. Malik, Shah, Iqbal and Rauf, (2010) have quoted that one of the major objective of Pakistani curricula of science education is to impart scientific knowledge particularly at elementary level (Elementary Science Curriculum, Govt. of Pakistan, 2006). Although the objectives of science education have never been entirely achieved satisfactorily in any country, however, efforts are being made to motivate the students towards the study of science at all levels.

Feist (2012) has revealed that “One important task for psychologists of science is to examine the psychological factors (such as personality or cognition) that underlie who becomes interested in science and what kind of attitudes people develop towards science.” Park, Lubinski, & Benbow (2008) and Subotnik & Steiner (1994a) emphasized that from social, psychological and economic perspectives the question of how and when interest and talent for science develops, is of great importance. Researches (Din, 2009; Bhatti, 2013) revealed that individuals have their own unique cognitive learning styles which are related with the academic achievement. Therefore, this being so, it is imperative to address these aspects.
1.2 Statement of the Problem

Science teachers face two kinds of challenges, how to involve the students during instruction for the continuous improvement, and how teachers can use student’s cognitive styles of learning to motivate them by improving their attitude towards science learning. Therefore, the problem of “teaching methodology” also needs to be addressed, for effective learning. This study was designed to make a comparison of cognitive learning styles and science related attitude of science students at undergraduate level.

1.3 Operational Definition

**Cognitive Learning Style:** Cognitive style is “individual’s habitual way of organizing and processing information.

**Science related Attitude:** Science related attitude is a favourable or unfavourable evaluative reaction towards science exhibited in ones beliefs, feelings, or intended behavior. In this study, attitude means science related attitude.

**Undergraduate:** It is the post-secondary education previous to the postgraduate education. It includes all the academic programmes up to the level of a Bachelor's degree.

1.4 Rationale for the Study

Tertiary education is considered vital for the development of human mind and personality throughout the world. It provides high-level skills and training essential for future careers. It provides capacity building and develops analytical skills. The fulfillment of these objectives heavily relies on the teaching learning process. An effective teaching learning process caters the individual needs of learners and enables them to think critically and solve problems effectively. It requires good understanding of cognitive learning styles of students. In Pakistan, there has not been much research on cognitive learning styles and science related attitude of science students, particularly at tertiary level. Most of the studies of learning styles and attitude have been conducted in social sciences and at secondary and higher secondary level. Therefore, there was need to explore the cognitive learning styles of
science students at undergraduate level so that improvements can be recommended for science teaching and learning at higher education level.

For the present study, Bipolar-one dimensional model was used. The wholistic-Analytic dimension is based upon Bipolar-one dimension. There are several streams of work contributing to the development of cognitive style under this dimension. But in this study, attention was focused on Field-Dependent/Field-Independent and convergent/divergent cognitive styles. The reasons to include these two styles for this study were that these are dominant cognitive learning styles over the other cognitive styles in the literature. Moreover, the previous research suggests these styles are related to the student’s assessment. Field-Dependency/Field-Independency identify “an individual’s mode of perceiving, thinking, problem solving and remembering”. Whereas, convergent/ divergent dimension deals with a type of thinking that is associated with problem solving strategies. These two dimensions are very much essential for science students.

In this study, the science related attitude of the learners were also explored as it is no less important in the advancement of science education. The curricula of BS Physics, Mathematics, Bio Sciences, Computer Sciences, Electrical Engineering, and Computer Engineering have been studied in detail for this research. It is revealed that no curriculum focuses on student’s science related attitude. Moreover, only three curricula focus on problem solving skills of students. This study was conducted to explore cognitive learning styles of science students and their science related attitude at undergraduate level. This study also explored the relationship of cognitive learning styles with science related attitude and academic achievement. The study was conducted to identify most common cognitive learning styles of science students and its relationship with science related attitude and academic achievement. The sample consisted of students from public and private sector universities of Islamabad. The sample of the study was homogeneous (in nature).
1.5 Objectives of the Study
The study intended to achieve the following objectives:
1. To identify and compare cognitive learning styles of science students.
2. To explore and compare science related attitude of science students
3. To find science related attitudes of science students with respect to cognitive learning styles.
4. To find relationship between cognitive learning styles and science related attitude of science students.
5. To find relationship between cognitive learning styles and academic achievement.
6. To find relationship between science related attitude and academic achievement of students.

1.6 Hypotheses
The following hypotheses were formulated for testing:
H₀₁. There may be no significant difference between Field- Dependent cognitive learning style of male and female undergraduate science students
H₀₂. There may be no significant difference between Field- Independent cognitive learning style of male and female undergraduate science students
H₀₃. There may be no significant difference between Convergent cognitive learning style of male and female undergraduate science students
H₀₄. There may be no significant difference between Divergent cognitive learning style of male and female undergraduate science students
H₀₅. There may be no significant difference between science related attitude of male and female undergraduate science students
H₀₆. There may be no significant difference between academic achievement of male and female undergraduate science students
H₀₇. There may be no significant difference between science related attitude of undergraduate science students having F.D and F.I cognitive learning styles
H₀₇ₐ. There may be no significant difference between science related attitude of F.D male and F.D female undergraduate science students
H07b. There may be no significant difference between science related attitude of F.I male and F.I female undergraduate science students
H07c. There may be no significant difference between science related attitude of F.D male and F.I male undergraduate science students
H07d. There may be no significant difference between science related attitude of F.D female and F.I female undergraduate science students

H08. There may be no difference between science related attitude of undergraduate science students having convergent and divergent cognitive learning styles
H08a. There may be no significant difference between science related attitude of CON male and CON female undergraduate science students
H08b. There may be no significant difference between science related attitude of DIV male and DIV female undergraduate science students
H08c. There may be no significant difference between science related attitude of CON male and DIV male undergraduate science students
H08d. There may be no significant difference between science related attitude of CON female and DIV female undergraduate science students

H09. There may be no significant difference between academic achievement of undergraduate science students having Field Dependent and Field Independent cognitive learning styles
H09a. There may be no significant difference between academic achievement of F.D male and F.D female undergraduate science students
H09b. There may be no significant difference between academic achievement of F.I male and F.I female undergraduate science students
H09c. There may be no significant difference between academic achievement of F.D male and F.I male undergraduate science students
H09d. There may be no significant difference in academic achievement of F.D Female and F.I female undergraduate science students

H010. There may be no difference between academic achievement of undergraduate science students having Convergent and Divergent cognitive learning style
H010a. There may be no significant difference between academic achievement of CON male and CON female undergraduate science students
H010b. There may be no significant difference between academic achievement of DIV male and DIV female undergraduate science students
H010c. There may be no significant difference between academic achievement of CON male and DIV male undergraduate science students
There may be no significant difference between academic achievement of CON female and DIV female undergraduate science students

There may be no relationship between F.D/F.I cognitive learning style and science related attitude of undergraduate science students

There may be no relationship between CON/DIV cognitive learning style and science related attitude of undergraduate science students

There may be no relationship between F.D/F.I cognitive learning style and academic achievement of undergraduate science students

There may be no relationship between CON/DIV and academic achievement of undergraduate science students

There may be no relationship between science related attitude and academic achievement of undergraduate science students

1.7 Significance of the Study

This study will be helpful for teachers of science at undergraduate level to know cognitive learning styles of their students. Teachers will be able to know the individual differences due to different cognitive learning styles. For, individual differences are correlated with higher achievement. The findings of the study will be helpful for educational practice of these dimensions of individual differences.

It will also be beneficial for teachers to plan their teaching method according to cognitive learning style of students in order to cater individual differences among the students and motivate them for better learning because knowing cognitive learning style of students is beneficial for teaching learning process. A good match between the cognitive learning styles of students and teaching methodology (according to cognitive learning styles) will yield good results of students. Knowing cognitive learning style of an individual student, teachers can motivate and engage students and provide academic and vocational guidance to them.
1.8 Research Design

The research design was as follows:

The study was a “Survey Research”. The study involved data collection from the respondents in the target population. In this research, quantitative approach was used. The variables such as age, gender, semester, previous score, and parent’s qualification were also considered for comparison purposes. In this research, data was collected through Cognitive Style Tests (Convergent/Divergent Tests and SHAPES). For the present study, a structured science related attitude questionnaires was developed to collect data. The academic achievement records of undergraduate science students were also obtained. The comparisons of the cognitive learning styles of science students from different science streams were examined. Moreover the correlation of cognitive styles with science related attitude, and academic achievement was examined. Moreover, the correlation of cognitive learning styles of science students, and correlation of academic achievement with science related attitude was also computed.

1.8.1 Instruments

The following research instruments were used.

1. Demographic Inventory

The demographic data of students was obtained by demographic inventory.

2. Convergent/Divergent Test

To identify the cognitive learning styles of students, convergent / divergent test was used.

3. Field-Dependent/ Independent Test

Field Dependence or Independence is the perceptual component of a particular cognitive style. Therefore, in order to identify the Field-Dependent or Filed independent cognitive learning styles of students, Hidden Figure Test (SHAPES) was used. The “SHAPES” measured the ability of a student to disemboby or pull out specified objects from a given background. The ability to disemboby has been shown
to be a necessary skill in problem solving and consequently thought of as a necessary
trait for individuals interested in engineering.

4. Science related Attitude Questionnaire

For this study, science related attitude questionnaire was developed to identify
science related attitude of students towards science. The science related attitude
questionnaire was based upon five point Likert scale ranging from strongly disagree
to strongly agree. This scale could measure the direction of science related attitude
(positive or negative towards science) and strength (strongly agree- strongly disagree)
of the science related attitude.

5. Academic Achievement Test Results

In order to identify the relationship of cognitive learning styles of students with
their academic performance, the results of their academic achievements were also
obtained from the respective universities/ DAIs.

1.9 Data Collection

The data was collected by administering the questionnaires/Tests on the selected
sample. In order to collect the data, the following procedure was adopted:

- Hidden Figure Test (SHAPES) was administered to the sample to identify the
  Field-Dependent/Independent cognitive learning styles of students.
- The Convergent/Divergent Test was administered to investigate
  Convergent/Divergent cognitive learning style of students.
- The science related attitude of students towards science was examined using
  science related attitude scale.
- The exam results were obtained to understand the sample’s academic
  achievements.
1.10 Population

The population of the study was undergraduate students studying science in different programs of public and private sector universities/degree awarding institutions (DAIs) of Islamabad. As per Higher Education Record (2012) (annexure attached), there were fourteen public and private sector universities/ Degree Awarding Institutes (DAIs) of Islamabad. BS programs in different disciplines are being offered in the universities. The total number of students was 4807 in BS Physics, Mathematics, Biosciences, Computer Sciences, Electrical Engineering, and Computer Engineering programmes. Therefore, the total population of the study was 4807 undergraduate science students of public and private sector universities/DAIs of Islamabad, Pakistan.

1.11 Sample

For the present study stratified random sampling was used. The sample consisted of three kinds of Science Strata as under:

i. Basic Sciences (Physics, Bio Science/Bio Informatics/Bio Technology/ Environmental Sciences, Mathematics),

ii. Computer Science (Computer Sciences)

iii. Engineering Sciences (Electrical Engineering/ Telecom Engineering, Computer Engineering)

The sample was drawn randomly from each stratum. Overall 25% undergraduate science students were selected through random sampling. The students of the first semester and the last (eighth) semester were included in the sample. The sample universities offering different undergraduate science programmes and the data were collected from the undergraduate science students in these universities / DIAs. However, the data could not be collected from AU, BU, AIOU, QAU, and PIAES due to several reasons. The detail has been given in chapter 3 of this study.
1.12 Data Analysis

In order to achieve the objectives of the study and test the hypotheses, percentage mean, standard deviation, chi-square, and t-tests have been used. The hypotheses were tested at 0.05 level of significance. To find the correlation between cognitive styles and science related attitude, coefficient of Spearman Rho correlation was found. Whereas, Pearson Correlation was used to find the correlation of academic achievement with science related attitude. The data was analyzed using SPSS-16. Tables and graphs were also used to present and summarize the data followed by discussion on the contents of data.
CHAPTER 2

REVIEW OF LITERATURE

In the research, review of literature has great significance. Several researchers (Boote & Beile, 2005; Cronin, 2011; Fink, 2014; Gay & Airasian, 2006; Jesson, 2011; Maxwell, 2006; Randolph, 2009; Ridley, 2012; Roberts, 2010; Strehler, 2008) have highlighted the significance of literature review. There are two main purposes of the literature review i-e it facilitates identifying theoretical framework that have provided guidance to design this study and enables to interpret the findings. Secondly it describes already recognized empirical studies (literature) regarding cognitive styles of learning, attitude and their relationship with academic achievement. According to Strehler (2008), “review of literature aims to identify any contradictions, ‘silences’ in the areas of research. It is these contradictions, silences, and gaps that provide pointers for the study” (p.20). This descriptive research was designed to understand the cognitive styles of learning, attitude of science students at undergraduate level. Therefore, in this chapter the related literature has been explored. This chapter has been divided into four parts.

PART- I

2.1 THEORETICAL FRAMEWORK OF THE STUDY

Science is known as process as well as product. It is considered as the rational, practical, and systematic study through observation and experimentation. The learning of students in science merely does not depend on their involvement with science content, but also with its methodology. The effective science teaching process incorporates both the components. The science study demands diversity of special instructional materials besides such materials which are similar mostly in all
kinds of education. Science instruction requires spatial and material essentials that are not similar to those considered in the planning of a general classroom. Therefore, the science teaching learning process must be diversified and resources must be available to the teachers for hands-on instructional strategies.

In the present era, scientific education becomes essential for all citizens. Therefore, it is the need of time that students must be familiar with the nature of science along with the processes of science and have a full science educational experience starting from kindergarten. The formation of scientifically literate society demands increasing number of students pursuing science education throughout their high school years and beyond.

2.1.1 Science Education

Science education covers content and processes of science. Besides this, science education also deals with philosophy of teaching science, psychological factors influencing science learning and the methods, techniques and strategies for teaching science. The target individuals include children studying in school, the students studying in colleges or the grown-ups.

Wieman (2007) described the purpose of science education as follows:

The purpose of science education is no longer simply to train that tiny fraction of the population who will become the next generation of scientists. We need a more scientifically literate populace to address the global challenges that humanity now faces and that only science can explain and possibly mitigate, such as global warming, as well as to make wise decisions, informed by scientific understanding, about issues such as genetic modification. (p.9)

This statement emphasizes the role of science education for decision making, informed scientific understanding and to deal with latest issues. Science teachers need to be experienced and have potential to conduct science research to develop their own critical thinking skills and make science fun and exciting for their students. They must provide theoretical and practical knowledge as well as skills in the areas of
science learning that are consistent with the National Science Teaching Standards included in National Science Curricula. Taylor, Jones, Broadwell, and Appeal (2008) emphasized that there is need to inspire creativity and a desire to learn science in students.

2.1.1.1 Why science education? The International Council for Science (ICSU) (2011) found that in most countries, the requirement for a scientifically literate public is gradually documented as critical and there are serious challenges for science education (EU, 2004, 2007; OECD, 2006a; OSTP, 2010; Roy. Soc., 2010; UNESCO, 2008) (p.7).

According to ICSU (2011) report:

Although some countries seem to be having some success in preparing their students in science, based on achievement scores, we do not yet seem to have a successful model for generating interest and motivation of large numbers of students towards careers in scientific disciplines. (p.9)

Hodson (2008, 2009) emphasized that during recent years, in various parts of the world and several organizations, “the call for greater scientific literacy” has been anticipated as important element of science education (p.1).

Teachers can play a vital role for the effective learning of students using constructive and several other recommended teaching practices for inspiring and mentoring future scientists (Bransford, Brown & Cocking 2000; Kastens & Rivet, 2008; Loucks-Horsley & Olson, 2000). The ICSU report has highlighted that unluckily, in several countries of the world, “teachers are not very much prepared to teach scientific subjects – and undoubtedly, may become cause of driving students away from scientific disciplines than inspiring them because of their lack of preparation (OECD, 2008; Shukla 2005)”(p.9).

Teacher’s lack of clarity about fundamental understanding of mathematical and scientific concepts can also serve basis for making the scientists of tomorrow. There are certain factors such as support for science teachers, professional
development, and continuing education so that teachers can prepare and facilitate science students to become scientifically literate. Certain measures are also helpful to encourage such students who intended to pursue scientific disciplines for their career. Much work is being done in several parts of the world to foster science education by applying cognitive science and improving student learning by evaluating through rigorously designed scientific studies.

Mestre (2001) has described that the joint contribution of teachers, scientists, cognitive scientists, and others can play vital role in learning. Mestre quoted that:

Learning is a complex process that is constructed by individual learners. Although cognitive science has provided us with many insights into the learning process, the field is relatively new, and much remains to be done. Secondly, today’s teachers should not just consider themselves teachers but also students of learning. The new breed of teachers not only needs to be knowledgeable in different areas, but also needs to be a life-long learner. Finally, reforming the educational establishment requires a long-term, sustained effort on several fronts…..reform, whether it is in curriculum or test development or in the design of strategic instruction, needs the involvement and cooperation of scientists, teachers, cognitive scientists, and commercial publishers…scientists should provide accurate scientific knowledge and insights on problem solving, teachers should provide expertise about children and about the culture of the classroom, cognitive scientists should provide insights on learning and instruction, and commercial publishers should reflect our current understanding about learning and instruction in their products. Such collaborations can bring improvement in science curricula, instruction focusing on scientific concepts and problem solving and achievement tests. (p.15)

According to Shahri, Javadi, and Esmael (2012), knowing the personality characteristics of learners and attention to their individual differences in the field of interests, attitudes, cognitive and emotional features and so on are important tasks of
teachers and experts of education. Recognizing individual differences among each personality dimensions can help us for more knowing of individuals and one of the knowing methods is reviewing in the field of their personality discussions (personality types). It means that what factors cause that features, characteristics and behavior of individuals is different from each other.

Several researchers highlighted different dimensions of individual differences associated with the higher academic achievement and suggested helpful actions for educational purposes (Babalola, 1989; Stephen 2002). Out of such dimensions, cognitive learning styles and attitude are most important. Emina (1986) stressed that, “Changes in learner’s behavior that can be possibly achieved through education cannot be solely attributed to cognitive style but also to affective orientations”. That’s why attitude being the “affective construct” has been considered as the foundation for “intellectual preparedness and motivation in learning” (p.177).

Reif (2008) highlighted that learning science and mathematics is difficult for many college and high school students because it requires different kind of thinking. It leads to fragmented knowledge, misconception, and inadequate problem solving skills. Most of the teachers and authors of text book have good knowledge of specific field but they have not full understanding of the underlying thought processes and types of knowledge necessary for learning of scientific domains. This explanation has signified the need to understand those aspects of learning which are necessary for learning science.

Tsaparlis (2001) has described that a number of supporting theories have been provided to science education through philosophy-epistimology and educational and cognitive psychology. For instance behaviorism supported the “direct transmission of knowledge from teacher” to learner. But, in science education, behaviorism remained external and it merely provided the means (i-e praise or punishment) that helped or prescribed the transmission of complete knowledge. There is a paradigm shift in the research programs of science education due to Piagetian cognitive theory (Cantu & Herron, 1978; Shayer & Adey, 1981; Tsaparlis, 2001, p.1).
Koballa (1989) emphasized the significance of affective domain and stated that:

The literature shows that the affective domain related to science education is mostly concerned with attitudes related to science. The development of positive attitudes toward science has long been viewed as a genuine goal of science education. (Changing and Measuring Attitudes in the Science Classroom, para. 2)

The curriculum developers of science have often searched for the improvement of student’s attitudes toward science and scientists. Koballa further stated that by improving student’s attitudes towards science, the enrollment in elective science courses possibly can be increased.

Science educators have always been concerned about the learning science, attitudes towards science, scientists, and scientific attitude. While discussing the “issues in science education”, attitude is broadly described in several contexts. Science educators want to maintain a positive movement towards making students science literate. A positive attitude towards different components of education in science can facilitate broader scale learning in science. The science related attitudes affect the participation of students in science subjects (AAAS, 1989; Shrigley, Koballa & Simpson, 1998) and also influence performance in science subjects (IAEP, 1992; Linn, 1992; Weiss, 1987).

Carey (1986) as quoted by Taber (2013) stated that efforts are being made for the improvement of science education and mathematics. Carey has provided “the cognitive orientation “for the subject matter teaching of science education and described that “to understand something, one must integrate it with already existing knowledge schemata. The paradox of science education is that its goal is to impart new schemata to replace the student's extant ideas, which differ from the scientific theories being taught” (p. 51).

Hollins (2011) emphasized that to support learners for developing academic skills, it is necessary for teachers to know deep content knowledge and discipline-
related practices which requires in depth knowledge of learning process, especially theoretical viewpoints on learning (p-398).

2.1.2 Cognition

Although numerous studies have been conducted regarding cognition in several disciplines, for example, linguistic, philosophy, computer science, and psychology. But, the use of this terminology differs across disciplines; this term is being referred as an “information processing view of an individual's psychological functions” in psychology and cognitive science. This term has also been used in the branch of social psychology entitled as “social cognition”, which describe the attribution, attitudes, and group dynamics (Sternberg & Sternberg, 2009).

According to Bloomberg (2011) as quoted by Modrak, Teodorescu and Gifu (2014), “in cognitive psychology and cognitive engineering, cognition is typically assumed to be information processing in a participant’s or operator’s mind or brain”p.56). Goldberg and Burdick (2009) have defined Cognition as “a collection of mental processes of knowing that includes awareness, perception, reasoning, and judgment” (p.1).

Cognition deals with the information processing, knowledge application and changing preferences. Cognition, or cognitive processes, can be natural or artificial or conscious or unconscious. In the view of Von Eckardt (1995), such processes have been analyzed from different perspectives within different contexts, particularly in the fields of psychiatry, anthropology, linguistics, psychology, neurology, anesthesia, systemic, and computer science.

In philosophy and psychology, the phenomenon of cognition is nearly associated with abstract concepts like mind and intelligence. Cognition covers the mental processes (thoughts), mental functions, and states of intelligent entities (human beings, human organizations, collaborative groups, highly autonomous machines and artificial intelligences).
2.1.2.1 Cognitivism. In 1900s, Cognitive theories were emerged out of “Gestalt psychology”, which was developed in Germany by three Germans including Wertheimer, Köhler, and Koffka. In 1920s, it was brought to America. The German word “gestalt” approximately means “configuration or pattern” and gives emphasis to the “whole of human experience” (Yount, 2010). According to Myers (2008), “Over the years, the Gestalt psychologists provided demonstrations and described principles to explain the way we organize our sensations into perceptions” (p.163)

Merriam, Caffarella & Baumgartner (2012) described that Gestalt psychologists criticized behaviorists for being so much reliant on overt (obvious) behavior. Gestalt Psychologists recommended exploring the patterns rather than isolated events.

Atherton (2005) as quoted by Ingleby, Joyce and Powell (2010) have described that “cognitive theory is interested in how people understand material, and thus in; aptitude and capacity to learn (thus fringing onto psychometrics and testing) and learning styles (p.68).” Atherton further elaborated that cognitive psychology is also the foundation for constructivism, which gives emphasis on learner’s role for the construction of knowledge.

Gestalt visions of learning have been combined in the form of cognitive theories. Wu, Hsiao, Wu, Lin and Hung (2012) as cited by Thomas (2014), there are two significant assumptions bring about cognitive approach: “the memory system is an active organized processor of information and prior knowledge plays an important role in learning”(p. 692).

Cognitive theories deal further than behavior and investigate the working of human memory to promote learning. Liliedfeld, Lynn, Namy and Woolf (2009, 2010) described that those educators who are influenced by cognitive theory are interested to understand short term and long term memory. Gestalt Psychologists consider “learning as an internal mental process (including perception, insight, memory and information processing) where the educator emphases on building
intelligence and cognitive development” (Westerheijden, Stensaker, Rosa, 2007, p 214).

De Jong (2010) explained that now a days, researchers are focused on topics like information processing theory and cognitive load. These learning theories have influenced instructional design. These theories are also helpful to describe certain issues as memory, intelligence (related to age) and social role acquisition.

2.1.2.2 Constructivism. It is established on the work of Jean Piaget and Jerome Bruner and highlights the significance of the active participation of the learner in knowledge construction, i.e building new concepts or ideas on the basis of previous experience and existing knowledge. Its emphasis is on the deep learning of students. Cognitive theory proposes that for designing effective teaching environments, a good understanding of learner’s previous knowledge is required. Lombardi (2011) also believed that the learning theories of John Dewey, Marie Montessori, and David Kolb provided the base for “constructivist learning theory”. DeVries and Zan (2003) mentioned that there are many varieties of constructivism such as (a) Active learning, (b) discovery learning, and (c) knowledge building.

All of these versions provide support for learner's free exploration within a certain structure or framework where teacher is like a facilitator and encourages students, allows them to discover principles and construct knowledge by working to solve real world problems.

Constructivism greatly relies on the psychological studies of cognitive development. For that reason, Smith (2002) suggested that designing of curriculum must be based on the learner’s previous knowledge and progressively develop with them. Yount (2010) proposed that while teaching complex problems, teachers must teach basic skills to solve problems. Therefore, a good understanding of the cognitive development of learner is required for it.
2.1.3 Theories of Cognitive style of Learning

Smith (2004, updated 2010) defined, “A person's cognitive style (his or her preferred way of looking at and interacting with the world) tends to remain stable throughout life and is influenced by such factors as personality, heredity, and brain injury” (p.105).

Smith described that:

Cognitive style theorists believe that in many cases students who are experiencing learning problems have intact learning abilities, but their styles of learning are inappropriate [emphasis added] for the classroom demands. This leads to under achievement and cumulative information deficits. On the other hand, when curricular demands match students' preferred learning styles and when students are taught more effective learning strategies, these students can learn well. (p105-112)

Therefore, for better learning and academic achievement, a good match must exist between learning style of teacher and learner.

Tipps, Johnson, and Kennedy (2010) described that:

There is a common believe in cognitive theories that mental processes occur between the stimulus and response. The same stimulus does not always result in the same response for all learners. Mental processes or cognition is not directly observable, results in highly individualized responses or learning. Human beings appear to create their own unique understanding from their experiences. (p.56)

Mergel (1998) as quoted by Strehler (2008) described that ‘Cognitive theories of learning’ were emerged in response to the perceived deficiencies of behaviourist theory. The focus of cognitive theory is on the mental activity “and is based on assertions about how information is processed and how the brain develops and uses schemas to consolidate the acquisition and construction of knowledge” (p.23).
Ally (2008) described that for cognitive theorists, learning is more than mere change in behavior and view “learning as an internal process that involves memory, thinking, reflection, abstraction, motivation, and meta-cognition” (para 13).

Martin (1998) elaborated the origin of cognitive theories and stated that:

Theories about cognitive style were developed as a result of early studies conducted by Witkin, Lewis, Hertzman, Machover, Meissner, and Wapner (1954); Witkin, Dyk, Patterson, Good enough, and Karp (1962); and Bruner (1966). These and other studies resulted in theories that generally assumed a single dimension of cognitive style, with an individual’s style falling somewhere on a continuum between the extremes of this dimension. Many of the theories assigned a positive value to one of the extremes and a negative value to the other. (p.123)

2.1.4 Cognitive Development Theory of Piaget

Psychologists and sociologists have been studying for many years the cognitive development or mental processes or the production of human thought. In Developmental Psychology, Jean Piaget was considered one of the most significant and prominent person. According to Piaget, human beings have distinctive feature as compared to animals. These distinctive feature of human beings enables them to do "abstract symbolic reasoning.” Piaget became famous for studying the cognitive development in children. According to Bjorklund (2013), Piaget’s theory describes the children’s stages which they pass through during development.

Parke and Gauvain (2009) described that the cognitive developmental theory of Piaget describes cognitive development of children from infancy to adult hood. Piaget has divided the cognitive development into four categories. In the view of Tipps, Johnson and Kennedy (2011), “Cognitive stages offer teachers a framework for understanding student’s thinking and some guidance for providing experiences that help them develop”.(p.58)
2.1.5 Classroom Implications

There are few classroom implications of Piaget’s theory. The process of learning is related with linking new information with prior knowledge and is cumulative. This theory suggests that tasks must be assigned to learners according to their respective age and appropriate stage. Brain (2001) has described that the learning of the learner is dependent upon certain variables.

2.1.5.1 Teacher variables. Student learning can be affected by the selection of method of instruction. It can also be affected by individual teachers and the way that they go about their task. Teachers may have several expectations and attitudes towards students, which can lead to stereotyping and labeling. “The action of the self-fulfilling prophecy can mean that these have a dramatic effect on the student’s performance and subsequent achievement.”

2.1.5.1.1 Teaching style. There are two different kinds of dimensions of looking at teaching style. One dimension is to consider the classroom setting and the style the teacher prefers to use in class, the other way is to look at the teacher’s own learning or cognitive style. The cognitive styles of learning of teachers and the way they approach the information is also important.

Brain emphasized that “there is still an emphasis on matching the teaching to the developmental stage of the child, through the use of structuring techniques such as Ausubel’s advance organizers and setting the material in context.” (p.101)

2.1.5.2 Variables of learner. Brain (2001) argued that learners are different from one another and that:

There are variations in the individuals regardless of their age, general cognitive ability, and motivation. The way they respond to different classroom situations is also different. They also differ in presenting the information and similarly in the approaches they acquire to study. These individual differences come under the “broad umbrella of learning styles. (p.106)
The teaching and learning process revolves around the learner. Learners use a number of strategies to process information and construct their own understanding of the content to which they are exposed. There are many variables which account for better learning in science education. These include cognitive styles and attitudes of students. The first framework of this research is the cognitive styles of the science students.

2.1.6 The Cognitive Approach to Education

The cognitive approach is based on information processing and has been used to explain cognitive development (Klahr and Wallace 1976). The idea is that the input comes to our brain through our senses (Halford, 2014). The input is changed in some way—by being stored, or manipulated, or adjusted to fit in with existing knowledge. Following that, there may be an output of some sort. In this way we process information rather than simply receiving it. It is the way we carry out the processing which is the center of interest in cognitive psychology.

When it comes to applying the cognitive approach in education, the main focus is on the way the memory works. Memory is the significant concept in the process of learning, and it is also a fundamental part of our knowledge about information processing. There has been a considerable amount of research into ways of structuring and organizing information in order to facilitate memory, and also into how we go about storing memory. (Brain, p.98)

According to Mandler (1983) as quoted by Brain, the information processing approach is stage-like, in that we discriminate by picking out information from the flow from our senses (the first stage), we see regularities in the information coming in (the second stage), and then we use problem solving processes (the third stage). Other researchers, however, have challenged the ‘stage’ idea. Klahr (online 2012, 1982) as quoted by Shrager and Carver (2012) argued that development is more continuous than stage-like, and that information is consistently being received and stored by the individual. Therefore, to achieve a full understanding of the educational process
there is need to draw on all three approaches—the learning approach, the cognitive-development approach and the cognitive approach.

2.1.7 The Basic Difference between Terminologies: Learning Style, Cognitive Style, Learning Strategy

In the educational literature, the terminologies learning styles, cognitive styles, learning strategies have not been used consistently (Bhatti, 2013; Din, 2009; Altun & Cakan, 2006; Mayer and Massa, 2003). Some have elaborated these terms under one term “cognitive styles” and other have used these terms under “learning styles” (Shi, 2011; Mainieri, Molz, Frozza, Schreiber, 2005; Logan and Thomas, 2002).

According to Cassidy, 2004, 2012; Webster, 2001; Liu and Ginther, 1999; Sadler-Smith, Riding, 1999, learning style and cognitive style “are—understandably—frequently used imprecisely in theoretical and empirical accounts of the topic. Whilst at other times they are afforded separate and different definitions (Jonassen and Grabowski, 1993).” Therefore, for better understanding, these terms need to be clearly differentiated.

2.1.7.1 Learning styles. Huang, Lin and Huang (2012) described that traditionally learning style was supposed to be a predictor of learning performance; however, little research has recognized the moderating and mediating effects between the two.

The term learning style has been used less consistently in the literature (Mayer and Massa, 2003; Din, 2009; Bhatti 2013). As described above, different educationists used the terms learning styles and cognitive styles interchangeably.

Similarly, Din (2009) described,

Many theorists see cognitive style as underlying learning style and involving theoretical academic descriptions of processes involved, while learning style is more immediately apparent and of interest to trainers and educators.
Cognitive style or thinking style is almost the same and they are not so evident but learning style is more prominent and easily observed concept. As learning style is more related to environment than cognitive style, therefore, it is more evident and more vivid than cognitive style. (p.18)

Wang (2008) defined that “Learning styles refer to an individual’s characteristics and preferred way of gathering, interpreting, organizing and thinking about information” (p. 30). There are variations in the individuals regardless of their age, general cognitive ability and motivation. The way they respond to different classroom situations is also different. They also differ in presenting the information and similarly in the approaches they acquire to study. In the last 23 years, there has been a sudden increase into these individual differences. All of which come under the “broad umbrella of learning styles”.

Brain (2001) has clearly differentiated the term cognitive style and learning style:

While this is largely true in practice, there is a slight difference between them. For example, a learning style is particularly concerned with a person’s approach to problem solving or to tackling learning tasks, whereas, a cognitive style has to do with a person’s characteristic ways of perceiving information, and their thinking strategies. Cognitive style may be part of a person’s learning style, but learning style also has an affective element, concerned with the person’s feelings and emotions. But often cognitive styles are referred to as learning styles, and the distinction is not really a crucial one. (p.108)

Brain further described that there is another way of looking at learning style i-e consider cultural effects. In the cultures which emphasize cooperation, students have the whole group in mind with respect to achievement. Other cultures which emphasize competitive learning, the individual is supposed to succeed and, is in competition with others in the group (p.108).
Riding and Rayner (2000) distinguished that:

Learning style and cognitive style are not exactly the same thing. If learning style is carefully represented as a profile of the individual’s approach to learning, cognitive style may be construed as part of a larger construct that might more properly be labeled a person’s learning style. A person’s learning style is then seen to comprise two fundamental levels of functioning: the first is cognitive, presumed to be more internalized, very stable, predictable, and related to the way a person thinks or processes information; the second is learning activity, presumed to be more external, embracing a less stable, less predictable set of functions that relate to a continuing adaption to the environment. pp.117-118)

This definition clearly describes the difference between learning style and cognitive style. Cano and Graton (1994) described learning style as “the manner in which learners sort and process information” (p. 6).

2.1.8.2 Cognitive style. Cognitive style is different from cognitive ability (or level). The intelligence tests or aptitude tests are being used to measure cognitive ability (level). It is the principal concept in the fields of management and education. If the cognitive style of a learner matches to his/her teacher, there are likelihoods of more positive impact on the learning.

Shi (2011) considered cognitive style a significant part of learning style and both are different from each other. Cognitive style is “individual’s habitual way of organizing and processing information (Liu, 2008, pp. 130-131), whereas, ‘learning style’ is a broader concept which not only contains information processing but also contains individual’s feelings and psychological behaviors” (Xuemei, 2009, pp.34-35). Cognitive style is considered as a vital part of learning style (Jing, 2009, pp. 129-130).

Sometimes these patterns are referred as \textit{learning and thinking styles}” (p. 405). There is great significance of cognitive styles researches and learning strategies researches in teaching. “On one hand, after learning students’ different learning styles, teachers can adopt relative(corresponding) teaching methods and strategies; on the other hand, students can choose appropriate learning strategies if they know their own cognitive styles, which can promote their autonomy and help them become successful learners” (Yaju, 2008, p. 63).

Lucas-Stannard (2003) described that the concept of cognitive styles has been used in many disciplines e.g. information sciences, computers and education. The common objectives of studying cognitive style are: “how learners/users (students, computer users, or information seekers) process information and how systems (teaching styles, computer interfaces, or information systems) can be better built to accommodate the diversity of the user population.” (p.142)

Cognitive styles of an individual identify the ways in which they respond to diverse circumstances. Cognitive style is an approach to distinguish individual differences. According to Webster (2001), “cognitive styles are more fundamental to the individual’s personal and psychological makeup”. In the views of Sadler-Smith (1996) cognitive styles and learning styles are “fundamentally quite distinct and having differing but complementary implications for the design of teaching”.

Riding and Cheema (1991) as quoted by Cassidy (2004) has described cognitive style in terms of a “bipolar dimension (Wholistic-Analytic), while learning style is seen as covering a number of components which are not mutually exclusive. It is also seen that cognitive style at the very least can be regarded as one significant component of learning style.”

According to Oughton and Reed, 1999, (as cited by Lee, Cheng, Rai and Depickere (2005), cognitive style is one of the frequently used measures of individual differences. Messick’s (1984) defined cognitive style as “individual differences in preferred ways of organizing and processing information and experience (Chen & McCredie, 2002; Sadler-Smith, 2001; Triantafillou, Pomportsis, & Demetriadis,
Saracho (1998a,b) described that cognitive style shows psychological differentiation of an individual to determine the response and functioning of an individuals in various situations that comprise choices, stable attitudes, and habitual strategies linked with style of an individual for perceiving, thinking, remembering, and problem solving.

Liu and Ginther (1999) distinguished that usually, cognitive styles are more concerned with the theoretical or academic research, whereas, learning styles are more concerned with the practical applications. Another main difference between these two terminologies is the number of style elements involved. Cognitive styles are more related to a bipolar dimension whereas, learning styles are not essentially either/or extremes. Cognitive Style is generally defined as a personality dimension which influences values, attitudes, and social interaction. Moreover, cognitive/learning styles in the literature have been viewed in three major respects i-e structure, process, or both structure and process (Din, 2009; Riding & Cheema, 1991).

According to Hartley (1998), “Cognitive styles are the ways in which different individuals characteristically approach different cognitive tasks; learning styles are the ways in which individuals characteristically approach different learning tasks.”

Riding and Rayners (1998) defined that “cognitive style refers to the way the individual thinks. These are our cognitive styles which direct us to process information in a certain manner” (p.7)

Saracho (1998) also described cognitive styles as follows:

Cognitive styles describe consistencies in using cognitive processes. It does not describe the content or cognitive level of an individual’s performance. Cognitive styles include stable attitudes, preferences, or habitual strategies that distinguish the individual styles of perceiving, remembering, thinking, and solving problems. (p.3)
According to Allport (cited by Riding and Cheema 1991), Cognitive Style is “an individual’s typical or habitual mode of problem solving, thinking, perceiving and remembering, while the term learning style is adopted to reflect a concern with the application of cognitive style in a learning situation”. Messick (1984) described cognitive style as pattern a person adopts to understand the world by collecting, analyzing, evaluating and interpreting the data (Ausburn and Ausburn, 1978). Similarly Goodenough (1976) have defined the term cognitive style as individual differences in the ways to perceive, think, solve problem and learn.

According to Witkin (1949) “cognitive style” might be more appropriately referred to as ‘personal style’ and describe mode of thinking, understanding, remembering, judging, and solving problems of an individual. An individual’s style determines the cognitive strategies applied in a variety of situations.

The following are some generalizations about cognitive styles:

1. There are distinct, observable, and measurable differences among people’s cognitive styles.
2. Cognitive style can easily be detected through language and nonverbal behavior patterns. Dialogue between individuals can reveal differences and can highlight the need for awareness and understanding of these differences. (Martin, 1998, p.2)

These generalizations describe that cognitive style can be measured and easily detected.

2.1.8.3 Learning strategies. Similar to cognitive styles and learning styles, the term “learning strategy” has also been used differently. The distinction between application of styles and strategies has been described by Messick (1984). According to Messick, “Style imply a general orientation to task situation, while strategies are attuned to particular types of tasks and situations” (p.62)

According to Shi (2011), cognitive styles have substantial impact on the selections of learners for learning strategies. Oxford (1990) as cited by Shi (2011), “learning styles are unconscious learner traits, but learning strategies are specific
actions taken by learners to make learning more efficient (pp.311-327). Jie & Xiaoqing (2006) revealed that although learning styles is different from learning strategies however, there is close relationship between these. Brown revealed that “learning strategies do not work alone, but rather are directly related to the learner’s distinctive learning styles and other personality-related factors” (Jie & Xiaoqing, 2006, p. 68).

According to Jarvis and Pell (2005):

Learning strategies are the ways individual adapt to the learning tasks at hand and the environment they are in. Given any learning task, we are faced with a choice of how we go about tackling it. This is influenced in part by our cognitive style, but also by habit, experience, motivation, and practical constraints such as the study time we believe to be available. (p. 74)

Cassidy (2004) stated that distinction between style and strategy reflects a frequent issue in the area. Hartley (1998) defined the strategies a student adopt while studying, and described that, “different strategies can be automatic than learning strategies which are optional”. An individual’s learning style can be understood like an “umbrella construct”, defining several aspects of an individual’s approach to learning. It has a “core” i-e cognitive style, which consequently influences a secondary set of processes including learning strategies, learning preferences, motivation, and self-perception as learner.

Many of us do prefer to study individually while others may study collectively. Learners also differ in the level understanding. Most of the learners may work at “surface level, making only minimal information while others may want in depth knowledge and understanding of the task. Cognitive styles are innate but learning strategies are opposite to it. Learning strategies are habits and are most likely changeable, although the change is not an easy task. A degree of insight is required for such changes. Now a days there is increase interest of researches in ways of informing learners about their existing learning strategies and the ideal strategies for their situation.
2.1.9 Cognitive Style: A Structure, Product or Both

According to Riding and Cheema (1991), as quoted by Fyle and Din (2009), historically cognitive style has been regarded in three different ways each having different implications. Several researchers considered it as ‘a structure’ i.e. it is ‘stable over time’. While some researchers considered it as process i.e. the focus is on the way it changes by time with the probability of instructors being in the position to affect that change. However, in the views of other researchers, cognitive style can be considered as both structure and a process, which means that it is somewhat stable but may be continually modified under the influences of new environment.

In this study, cognitive style has been considered as both structure and process.

2.1.10 Significance of Learning styles, Cognitive styles and Learning strategies in Teaching and Learning

According to Vengopal and Mridula (2007), “what happens to us in life depends on not just ‘how we’ think, but ‘how well’ we think and learn”. Individual’s styles of learning and thinking have a great influence and play a major role. Teaching and learning processes are mismatched in academic institutions. There exists difference between the teaching and thinking styles of the teachers and learning and thinking styles of students because these differences are not tied up to the understanding and thinking abilities of students. Still, several educators are confused about the styles of students in learning and thinking process; what effect these styles have on learner’s performance in schools and why attention should be given to learner’s performance to assess their levels of ability.

Therefore, various studies have been done to understand the process of education in a better way. There are many studies which have focused on student’s and teacher’s personal characteristics. There are assumptions that the personality
factors of an individual effect in a direct or indirect way into good teaching and learning performance (Saracho, 1998).

Tobias (1990) described that “learning styles are collections of personal characteristics, strengths, and preferences, describing how individuals acquire, store, and process information. Learning style factors include information processing modes, environmental and instructional preferences, cognitive capabilities, and personality features”. Tobias elaborated that science “teachers must know how to identify learning and teaching styles and how to teach various learning strategies” (p.2). According Saracho (2003) “adapting instruction to the students’ needs, requiring the teachers to become flexible in their cognitive style effective teaching and successful learning can be determined by what teachers and students do” (p.171). Teachers can teach through “differentiated instruction” because of its diversity to fulfill the student’s needs while respecting the diversity. A flexible approach to teach and assess student’s learning will be beneficial for learners. An awareness of the cognitive styles of teachers and students is helpful for teachers so that learning can be maximized. Here are some models and measures of cognitive style, and their educational implications.

2.1.11 Models for the Measurement of Cognitive Styles

Brown, Brailsford, Fisher, Moore, Ashman (2006) have defined cognitive style as “a psychological construct relating to how individuals process information” (p.327). There are several classifications such as “field-independent style and field-dependent style, analytic style and global style, reflective style and impulsive style, and tolerance and intolerance of ambiguity”.

Cassidy (2004) has described that , “The preferred way in which an individual approaches a task or learning situation-their learning/cognitive style or approach or strategy –has been characterized in several ways based on variety of theoretical models” (p.421). According to Riding & Cheema, 1991 as quoted by Lucas-Stannard (2003), “cognitive style is unique in its polar nature, having an ‘either or’
measure, where the absence of one characteristic implies the presence of its extreme. This is in opposition to personality measures that are more multifaceted (p.3)

There are various kinds of models and measures for cognitive styles i.e Multi-dimensional Models and Measures, two dimensional model and measures and bipolar one-dimensional models and measures. Here is the review and characterizations of models.

2.1.11.1 Multi-dimensional models and measures. It includes Curry’s Onion Model and Myer Briggs Type Indicator (MBTI) and Curry’s model.

2.1.11.1.1 Myers-Briggs Type Indicator (MBTI). It is another famous, multi-dimensional tool for measuring the cognitive style. According to Din (2009), MBTI scale was derived from Carl Jung’s theory. The concepts of Extraversion/Introversion were introduced by Carl Jung. The concepts of ‘Sensing/Intuition, Thinking /Feeling, and Judging/Perceptive’ were used in Myers - Briggs Type Indicator.

2.1.11.2 Curry’s Onion Model. According to Din (2009), Curry (1983) had used an onion metaphor to present a layer like model of learning behavior. Initially there were only two layers of the construct. Curry included third layer of model, then a fourth layer of “social interaction” was added in it.

2.1.11.2 Two dimensional model and measure. According to Riding and Cheema (1991), there are approximately 30 identical definitions used to describe cognitive and learning styles. Learners vary in terms of two fundamental and independent dimensions of cognitive style (information processing): the Wholist-Analytical (W-A) dimension and the verbalizer-imager (V-I) dimension (Graff, 2003a, b; Riding and Rayner, 2013; Smith and Riding, 1999). The model proposed by Riding & Cheema, 1991 is still being used in different settings (Strehler, 2008; Chen, Ghinea & McCredie, 2006).

i. Wholistic-Analytic dimension represents an individual’s way of information processing either as a whole (Wholistic) or broken down into
components parts (Analytic). According to Nickerson, Perkin, and Smith (1985) as quoted by Riding and Cheema, the wholistic–analytic dimension has related terms: analytic-deductive, rigorous, constrained, divergent, informal, diffuse, and creative. This dimension reflects how individuals ‘organize and structure information’.

ii. The verbalizer-imager dimension describes the degree to which individuals tend to ‘represent information’ either in the form of words (verbalizer) or as images (imager). This dimension describes a person's mode of information representation in memory during thinking.

These two fundamental cognitive styles exist independently and are not reliant upon one another. Riding (1991) had developed an assessment tool i.e cognitive style analysis (CSA) which integrates these two dimensions. According to Wikipedia (2013), CSA has been the subject of much empirical investigation. Rezaei and Katz (2004) showed that the reliability of CSA to be low, however, some changes are being made (as of 2004) in a revised version to improve its validity and reliability (Peterson, Deary, Austin, 2003).

2.1.11.3 Bipolar, one-dimensional models and measures. Witkin et al., had introduced Field dependence-Field independence model which involves bipolar, value neutral continuum. This model identifies the perceptive behavior of an individual for distinguishing object figures from the content field in which they are set. Hudson (1967) identified two cognitive styles i.e convergent thinkers and divergent thinkers. The convergent thinkers accumulate relevant material from several sources to solve problems. On the other hand divergent thinkers proceed more subjectively and creatively in problem-solving.

Hemispherical lateralization concept of Ornstein (as quoted by Carey and Gelman, 1991) usually known as left-brain/right-brain theory, suggests that the logical and analytical operations are controlled by left hemisphere of the brain whereas, intuitive and pictorial activities are controlled by right hemisphere. Hence, such cognitive styles are claimed to be single dimension on a scale from one extreme to other extreme.
Cassidy (2004) revealed that Riding and Cheema proposed various models of cognitive style which can be considered under these dimensions (or families). Figure 2.1 describes examples of these family groupings along with the categorical framework proposed by Curry (1987) and Rayner and Riding (1977).

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Within (1962) Field-dependence/independence
Kagan (1965) Impulsivity-reflexivity
Holzman and Klein (1954) Leveller-sharpen
Pask (1972) Holist-serialist
Pavio (1971) Verbaliser-visualiser
Gregorc (1982) Style delineator
Kauffmann (1979) Assimilator-explorer
Kirton (1994) Adaption-innovation
Allinson and Hayes (1996) Intuition-analysis
Kolb (1984) ELM
Honey and Mumford (1992) LSQ
Vermunt (1994) LSI
Entwistle & Tait (1995) Surface-deep
Biggs et al. (2001) SPQ
Schmeck et al. (1991) ILP
Hunt, Butler, Noy, and Rosser (1978)
Conceptual level
Dunn, Dunn, and Price (1989) LSI
Reichmann and Grasha (1974) Styles of learning interaction model
Ramirez and Castenada (1974) Child rating form
Reinert (1976) ELISIE
Hill (1976) Cognitive Style Interest Inventory
Leteri (1980) Learner types
Keeffe and Monks (1986) Learning style profile
2.1.12 Implications of Learning Style in Designing the Instructional Design

De Bello (1990) described that educational personal wish to apply learning style to stimulate more effective learning. Curry and Adams (1991) stated that “the failure to identify and agree upon style characteristics most relevant to learners and instructional settings as a major concern in the field”.

Beishuizen & Stoutjesdijk (1999) described that learning style is considered as a “consistent or habitual mode” of acquiring or imparting knowledge through study, experience, or teaching. McLoughlin (1999) described that for instructional designers, individual differences are of extreme challenge. The research has revealed that the quality of learning material enhances if the instructional material is designed by keeping in view learner’s individual differences (Rasmussen, 1998; Riding & Grimley, 1999). Therefore, while designing for diversified classes, the research literature on learning styles have the potential to provide understandings for the improvement of instructional design.

2.1.13 Applying Cognitive Science to Education

According to Reif (2008), many students face difficulty to learn the kind of thinking and knowledge required by college or high school science courses e.g. mathematics or other complex domains. It results fragmented knowledge, significant misconceptions and inadequate problem-solving skills. Reif revealed that “although majority of the instructors or textbook authors approach their teaching efforts with a good knowledge of their field of expertise but they have little awareness of the underlying thought processes and kinds of knowledge required for learning in scientific domains”. Reif explored the relevance of cognitive science to science education and proposed that a better understanding of the essential cognitive mechanisms can help to adopt a more scientific approach to science education.
2.1.14 Benefits of Cognitive Styles

Martin (1998) has described certain benefits of cognitive styles. Martin proposed that by using instruments and models to identify cognitive style of individuals, groups, and organizations, the human resource development practitioner can achieve the following:

- Help people to identify their own cognitive styles and to understand the benefits as well as the drawbacks of all cognitive styles;
- Teach people how to predict their own behaviors as well as those of others with regard to thinking, learning, and problem solving;
- Prescribe developmental strategies that people can use to enhance their own cognitive styles and/or to build strength in styles that they do not generally use;
- Increase people’s skill and flexibility in various problem-solving situations; and
- Facilitate the interactions between individuals and groups. (p 1).

2.1.15 Examples of Learning Styles in Action

Cassidy and Eachus (2000) measured learning styles of undergraduate students by using the “approaches and study skills inventory for students” (Tait & Entwistle, 1996). It was revealed that there was positive association between academic achievement and strategic approach. McManus, Richards, Winder, and Sproston (1998) found that the students' learning styles were associated with the amount of knowledge gained from clinical experience. Biggs (1987) also revealed that a strategic and deep learning style was positively correlated with amount of knowledge gained from clinical experience. Bates (1994) emphasized that individual’s learning styles must be considered by providing diversified learning situations where learners have opportunities for the development of a full range of styles. Birzer (2003) illustrated that police training must be carried out by keeping in view the individual differences in learning and adopt student-centered approach.
Summary

There are number of supporting theories which have been provided to science education through phiiosophy-epistimology and educational and cognitive psychology. Science educators have always been concerned about the learning science, attitudes towards science, scientists, and scientific attitude. While discussing the “issues in science education”, attitude is broadly described in several contexts. Cognitive theories of learning are based upon cognitive psychology. Many researchers believe that “Cognitive learning theory” is a combined term for numerous theories developed from the 1950s onwards. These theories had been formulated in response to the observed deficiencies of behaviorist theory. For cognitive theorists, learning is more than changes in behavior and emphasized that in fact learning takes place even if there is no external change in the behavior of a learner. Cognitive theorists view learning as an internal process that involves memory, thinking, reflection, abstraction, motivation and meta-cognition. Cognitive theory emphasis on the mental activities that takes place while learning. It also emphasis how information is being processed and how the brain develops and uses schemas to consolidate the acquisition and construction of knowledge. In other words cognitive theory of learning puts emphasis on the role of cognitive processes and makes sense of the information provided in learning. The term learning style has been used less consistently in the literature. Learning styles is a broader term and refer to “an individual’s characteristics and preferred way of gathering, interpreting, organizing, and thinking about information”. However, cognitive style is “an individual’s typical or habitual mode of problem solving, thinking, perceiving, and remembering, while the term learning style is adopted to reflect a concern with the application of cognitive style in a learning situation”. There are various kinds of models and measures for cognitive styles i-e Multi-dimensional models and measures, two dimensional models and measures and bipolar one-dimensional models and measures. There are several models and measures of each dimension. Riding and Chema proposed a famous bipolar, one dimensional model of cognitive style i-e Wholistic-Analytic and Verbalizer-Imager. There are many models and measures which belong
to this dimension. Out of which Field-Dependent/Field-Independent and convergent/divergent cognitive style has been used many times in science education. There are several implications of cognitive theories in teaching learning process. The researches have revealed that the quality of learning material can be enhanced if the instructional material is designed by keeping in view learner’s individual differences.

PART-II

2.2 ATTITUDE

This section contains literature about attitude, its structure, function, importance, and different measures to measure. Moreover, the related literature about attitude towards science has also been included. This section also contains different kinds of attitude scales used in science education.

Attitude has been defined in numerous ways. It has frequently been quoted interchangeably with certain terms as interest, motivation, value, and opinion. However, the values are broader and complicated than attitudes and tend to be more enduring.

According to Osborne, Simon and Tytler (2009), attitudes to science have been significant in science education. Perrier and Nsengiyumva (2003) stated that a contemporary view is that the “affective dimension is not just a simple catalyst, but a necessary condition for learning to occur (p. 1124)” . However, this construct has gained much less consideration than the cognitive dimensions. Alsop and Watts (2003) had described that the “reasons for this imbalance include the archetypal image of science itself, where reason is separated from feeling, and the long-standing cognitive tradition of science education research (p. 1044)” . In science education, there are two main constructs of affective domain i-e attitude and motivation.

Lee, Wub, and Tsaic (2009) reported in a citation report that during the past decade, numerous publications regarding attitude have raised anxiety in the developed countries about the future supply of scientists and technologists. In UK
and USA, the research is being conducted to address the problem with interest of students studying science, mathematics, technology, and engineering. “Policy makers who have been persuaded by such reports that there is an issue to be addressed have looked to research in science education for evidence to inform the decision making process” (Osborne, Simon and Tytler, AERA, 2009, p.2)

2.2.1 What is Attitude?

An attitude is an expression of favor or disfavor towards a person, place, thing, or event (the attitude object). Another definition is, “Attitude is a tendency to think, feel, and act positively or negatively toward objects in our environment” (Salta & Tzougraki 2004; Simpson and Oliver, 1990).

According to Koballa (2008), the affective domain (has been derived from the Latin word ‘affectus’, meaning "feelings") comprises a host of constructs, such as attitudes, beliefs, values, opinions, motivation and interests.

According to Allport and Gordon (1935) as cited in Wikipedia described that “attitudes are the most distinctive and indispensable concept in contemporary social psychology.” Attitudes can be developed from the past and present of an individual. According to Myer (2006) as quoted by Donerlson (2008), “attitude is a favorable or unfavorable evaluative reaction toward something or someone exhibited in ones beliefs, feelings, or intended behavior” (p. 15).

2.2.2 Definitions of Attitude

Jung (1921; 1971) has defined that, “attitude is a ‘readiness of the psyche to act or react in a certain way’” (Pittman, p.51). According to Eagly and Chaiken (2007) and Ajzen (2001), "attitude is a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor (p.1)". According to Wood (2000) as quoted by Maina (2013) argued that:

The definition of attitude allows for one's evaluation of an attitude object to vary from extremely negative to extremely positive, but also admits that
people can also be conflicted or ambivalent toward an object meaning that they might at different times express both positive and negative attitude towards the same object. (p.51)

Whether explicit (deliberately formed) or implicit (subconscious), attitudes have been focused of many researches. Both Implicit and explicit attitudes affect the behavior of an individual in many ways. Miller (2005) has stated that the components of attitudes are part of most of instructional plans (whether or not these have been specified clearly).

Hogg & Vaughan (2008) defined attitude as, “a relatively enduring organization of beliefs, feelings, and behavioral tendencies towards socially significant objects, groups, events, or symbols” (p. 150). Attitudes may be founded on our feelings, our knowledge, or our behavior and may affect future behavior. According to Reid, "attitudes must have a target”. Attitudes have significance in teaching and learning science can affect learning and are extremely complex in nature.

2.2.3 Nature of Attitude

According to Pitafi and Farooq (2012), attitude is a complex phenomenon. Generally, psychologists are of opinion that the attitudes are not intrinsic; rather they are learnt and are enduring like all other learning (Freeman, Travers 1973). Attitudes are also being considered as culture oriented because attitudes are developed in a society, both formally and informally (Janzan, 2001). Attitudes are developed as individuals are exposed to the ideas of different persons e.g., parent, teachers, peers, legends of culture and many significant others (Lasley, 1975). Attitudes are usually unchanged, except deliberately or explicitly challenged. The group norms are one of the most important factors, constituting, a pressure toward conformity of attitudes and behavior (Karlinger 1970). An important aspect of attitudes is their hierarchical and collateral nature within the frame of work of an organized and unified mental state designated as mental set.
Rozenberg as quoted by Kruglanski and Stroebe (2005) that attitude is a “tendency to respond to an object with positive or negative affect is accompanied by cognitive structure for attaining or blocking the realization of valued states”. Thus, a unified and organized mental state, called mental set, composed of beliefs, values, likes and dislikes etc., influence learning and modification of attitudes.

Murphy and Kluver (1999) summarized the work of Razern and concluded that the attitudes of the subject make a deep difference in determining which of the several possible conditioned responses will be established at a given time. It concludes that attitudes control behavior through a process of selection in the range of available responses.

2.2.4 Why is Attitude Important?

The development of Attitude is ongoing process. The students develop attitude whether teachers ignore them in their teaching and learning (Reid, 2006, p. 33). According to Kaya, Bahceci and Altuk (2012), science and technology course that helps to improve cognitive aspects and enhance the creativity of the individuals is an important part of school education as a core course. Students may gain scientific knowledge, scientific process skills, and attitudes during their science learning process.

According to Smith, Walker and Hamidova (2012), learners’ attitudes characterize an important element of their affect towards particular subject domains in school. Students’ attitudes may, for example, influence their motivation to pursue study in a domain and persist in their effects to attain subject matter mastery. In the classroom, students’ attitudes reflect how they manage their perceptions regarding academic content and learning, and their behaviors. Thus, attitudes facilitate learning. But, they are also products of students’ learning activities.

Chang, Yeung, and Cheng (2009) described that although many studies regarding student’s attitude towards science and learning interest have been
conducted for many years. But, the link between them and with the life experiences (about science and technology) has not been considered much.

Trumper (2006) as cited by Sarjou, Soltani, Kalbasi and Mahmoudi (2012) described that:

Students’ increasing reluctance to choose science courses, and physical science courses in particular, in their final years of secondary education has important implications not only for the continuity of scientific endeavor but also for the scientific literacy of future generations. As a result, development of positive attitudes towards science, scientists, and learning science, which has always been a constituent of science education, is increasingly a subject of concern. (p.92)

This statement signifies the need for the development of positive attitudes towards science.

Bukhari and Safdar (2011) quoted Reid (2003) that:

Attitudes are important to us because they cannot neatly separate from study. It is a relatively quick series of steps for a student with difficulty in a topic to move from that to a belief that they cannot succeed in that topic, that it is beyond them totally and they, therefore, will no longer attempt to learn in that area. A bad experience has led to a perception which has led to an evaluation and further learning is effectively blocked. Attitudes in life let us to “make sense of ourselves, make sense of world around and make sense of relationship (South Asian journal of Management Sciences, p.35-36)

Bukhari and Safdar further emphasized that:

It is necessary to inculcate in our students the intellectual sense of the world around them that is the very nature of the subject matter of the physical sciences (and other sciences) of course. It helps them to contribute to the
understanding of the world if they can also make sense of themselves and others. (South Asian journal of Management Sciences, p.26)

According to Osborne, Simon, and Collins (2003), “although the promotion of favorable attitudes towards science, scientists and learning science is increasingly a matter of concern. However, the concept of attitude towards science is not clear to an extent, often poorly expressed, and not well understood” (p.1049)

Ajzen and Fishbein (1980) stated that understanding attitudes can help in predicting the behavior of the individuals.

Johnson (1979) stated that the assessment of attitudes of students provide useful information to improve and modify the instructional programs. Johnson further argued that “the components of instructional program such as teaching strategies and curriculum materials can be modified on the basis of student’s attitudes they promoted” (p.500)

2.2.5 Attitude Formation

Petty (2014) quoted Doob (1947) that “learning can account for most of the attitudes we hold”. The attitude formation studies strive to know of “how people form evaluations of persons, places, or things”. Argyriou and Melewar (2011) quoted Zajonc (1968) that unlike personality, attitudes are anticipated to change as a function of experience. Moreover, exposure to the 'attitude' objects may have an effect on how a person forms his or her attitude. The repeated exposure of an individual to a stimulus is a sufficient condition for the enhancement of attitude towards it.

Attitudes perform certain functions. McLeod (2009) has described following functions of attitudes:

2.2.6 The Functions of Attitude

Katz (1960) as quoted by McLeod (2009) had outlined four functional areas of attitude:
1. **Knowledge.** Attitudes provide knowledge for life. Attitudes can help individuals in organizing and structuring their experience. Knowing the attitude of individual helps to predict his/her behavior.

2. **Self / Ego-expressive.** Attitudes are part of our identity and support us to be aware through expression of our feelings, beliefs, and values.

3. **Adaptive.** Socially acceptable attitudes provide approval of people for social acceptance. The adaptive function of attitude helps to fit in a social group.

4. **Ego-defensive function.** It refers to hold such attitudes that protect our self-esteem or that justify certain actions that make us feel guilty.

Attitudes provide particular functions for individuals. The functional approach of attitudes helps individuals to mediate between their own inner needs (expression, defense) and the outside world (adaptive and knowledge).

### 2.2.7 Attitude Change

Khamari and Guru (2013) stated that although attitude is lasting and consistent but it can be modified. Attitudes can be changed through “persuasion” which is a significant domain of research on attitude change and emphasis on responses to communication. Experimental researches into the factors that can affect the persuasiveness of a message include:

1. **Target Characteristics:** These are certain characteristics of a person who receives and processes a message. Intelligence and self-esteem are examples of target characteristics. For example individuals of moderate self-esteem can be convinced more easily than those of low and high self-esteem levels (Rhodes & Woods, 1992).

2. **Source Characteristics:** The main source characteristics are expertise, interpersonal attraction, trustworthiness, and attractiveness. Hovland and
Weiss (1951) explored the effect of telling people and found that a message coming from a trustworthy source vanished after some weeks.

3. **Message Characteristics**: In the persuasion, the nature of the message plays an important role. Time and again, presenting both aspects of an event are beneficial and support the change of attitudes.

4. **Cognitive Routes**: A message can be appealing to an individual's cognitive evaluation to help change an attitude. In the persuasion, the individual is presented with the data, motivate to evaluate the data and arrive at an attitude change.

### 2.2.8 Structure of Attitudes

Johnson and Boynton (2010) quoted that LaPiere (1934) has described the structure of attitudes in terms of three components:

i. **Affective component**: this involves a person’s feelings / emotions about the attitude object.

ii. **Behavioral (or conative) component**: the way the attitude we have influences how we act or behave.

iii. **Cognitive component**: this involves a person’s belief / knowledge about an attitude object. For example: I believe spiders are dangerous. (Mackie, Smith, 2004, pp.153-154)

Augoustinos, Walker & Donaghue (2006) had also described this “Tripartite” (three-view) of attitudes. It is recognized as the “ABC model of attitudes”. Usually, these three components of attitudes are associated but do not overlap. However, few researches have revealed that “the cognitive and affective components do not always match with behavior” (p114-115).

Sua (2007) stated that attitude is a hypothetical construct. McLeod (2009) described that, “the most straightforward way of finding out about someone’s attitudes would be to ask them”. Various methods of attitude measurement have been
developed along with some limitations. Several measures emphasized various components of attitudes – cognitive, affective and behavioral (Fazio and Olson, 2007). Visser, Bizer and Krosnick (2006) described that despite evaluation, there are other characteristics of attitudes e.g. certainty, importance, or accessibility and associated knowledge.

Johnston (1997) stated that “attitudes can be described as adopted postures or positions or expressions of views or thoughts that have an effect on behavior, ideas, or emotions” (para.5). This gave the “tripartite view of attitude”, emerged out of Hovland's Learning Theory Model (Hovland, Irving & Kelly, 1963) “which separates affective, cognitive and behavioral aspects of attitude. Affective attitudes are the basis of both cognitive and behavioral attitudes, so that how we behave is a result of how we think and an inter-relation of how we feel and think” (para.5).

![Figure 2.2 Tripirate views of Attitudes (Johnston, 1997)](image)

Gardner (1975) and Johnstone (1997) both have clearly stated that “in science and science education, the major division has been in terms of scientific attitudes that are cognitive and behavioral attitudes necessary to undertake scientific inquiry, to be scientific, and attitudes towards science or affective attitudes”.

Johnston further described changing scientific attitudes are deep-rooted in behavior and cognition (Harlen, 1977). Both education and research has emphasized the continued need for the development of affective attitudes to science, not only in children but teachers and initial teacher training students (Johnston, Ahtee & Hayes 1996, Watters & Ginns, 1994), and also parents (ASE, 1992 Johnston, 1995) (Johnston, 1997, para 7-9)
2.2.9 Measurement of Attitudes

According to Johnston (1996), “measurement of affective attitudes has been problematic as there are questions about what attitudes are being measured and how they are measured”. Ramsden (1998) as cited by Siegel and Renney (2003) has described that researchers have used direct interviews, Likert scales, semantic differential scales, Thurston scales, and projective methods to measure attitude towards science.

According to Reid, there are two ways used to gain insight into student attitudes:

- a. Asking them to respond to any kind of written “test”
- b. Talking to students—any kind of organized interviewing

2.2.9.1 Written test. Reid described that these are often known as ‘questionnaires’. A common misconception about such questionnaires is that these are extremely unreliable and of limited value. However, evidences have shown that it is not necessarily be the case. In fact, a well-structured questionnaire can give enormously accurate insight into how students think and the way they evaluate situation and experiences.

Gay (1987, p.146) has described four basic kinds of scales used to measure attitude. It includes i. Semantic differential scale, ii. Thurston Scale, iii. Likert, and iv. Guttmann Scale. These can be used in pedagogical research in recent years.

For many years, attitudes were assumed as ascertainable and non-measurable. According to Reid, around 1929, the first serious attempt was made to measure the attitudes. It was then followed by Likert who devised a technique called “Likert Scale” which is commonly used nowadays.

Likert scale is versatile and there are many advantages of this scale i.e: it is easy to create, can be consisted of a numerous items that can be responded rapidly, can give precise information about degree of an agreement or disagreement of
respondents, and can give high reliability (Oppenheim, 1992). In this scale, a statement about something is made and is then followed by a series of numbers which people can choose to show how much they agree with something. The sum the numbers for several statements gives a score that represents the person’s attitude towards the subject. Reid emphasized that semantic as well as Likert both are recommended for the measurement of attitudes. Six and five point scales are appropriate.

2.2.10 Attitude in Science Education

According to Nasr and Soltani (2011), “the interest in science courses and careers is declining with the rapid global scientific and technological growth. It has prompted science education reform efforts on an international scale” (p.100).

Osborn et al. (2003) described that, “the concerns about attitude towards science are not new” (p.1050). One of the important goals of science education is to generate positive attitude towards science among science students. The researchers in education have given great attention on the “attitude” construct. Erdemir (2009) as cited by Oba and Lawrence (2014) elaborated that, “attitude organizes thoughts, emotions, and behaviors towards a psychological object. Some attitudes are based on people’s own experiences, knowledge and skills, and some are gained from other sources” (p54.). Similar to attitude, the definition of attitude towards science has also been an issue among the researchers. Science educators have been struggling with defining science attitudes (Shrigley, Koballa and Simpson, 1998) and differentiating among attitudes, beliefs, and values (Kobolla, 1988, Koballa and Glynn, 2007). Gardner as quoted by Bennett (2001) and Zaman (1996) had made a distinction between attitude towards science and scientific attitude. Gardner (1975) defined “attitude towards science as, learned predisposition to evaluate ….. Objects, people, actions, situations or propositions involved in learning science” (p. 2).
Bennett (2001) and Zaman (1996) further stated that:

Attitude towards science is linked with the views and images that an individual develops about science as a result of interaction with different situations, while the term scientific attitude is linked to the ways of thinking or scientific method, which covers the skills and is related to the undertaking of practical work.

A comprehensive review of attitude towards science has been presented by Blalock, Lichtenstein, Owen, Toepperwein, Marshall, Lichtenstein, Blalock, Pruski, and Grimes (2008). They have categorized attitude towards science into four areas; a) attitude towards science, b) scientific attitude, c) the nature of science, and; d) scientific career interests. Klopfer (1971) as cited by Shah and Mahmood (2011) pointed out that “displaying favorable attitude towards science and scientists, considering thought as scientific enquiry, enjoyment in science learning experiences, changing the attitude towards scientific reasoning, interest in science related activities and science careers are all treated as attitude towards science”(p 72).

Owen et al, 2008 found that the student’s attitudes toward science influence selection of courses and career. Bak (2001) stated that scientific community and social scientists are of concern that ‘how ordinary people perceive science’. There are certain factors which influence student’s learning in science and attitude towards science (Adesoji, 2008). These factors include locus of control, self-concept, and achievement, locus of control, motivation, class mates, administrative styles, teachers, family environment, and parental background.

Francis and Greer (1999) stated that in education, attitudes have been documented significant predictors of individual differences, learning, and achievement (Evans, 1965). Particularly, science educators have provided much importance to the attitudinal dimensions of their subject (Koballa, 1988; Laforgia, 1988). Therefore, an extensive research work (e.g. Aiken & Aiken, 1969; Pearl, 1974; Ormerod & Duckworth, 1975; Gardner, 1975; Gaulda & Hukinsa, 1980; Haladyna, Olsan & Shaughnessy, 1982; Schibeci, 1984, 1985; Laforgia, 1988) is available regarding empirical exploration of attitudes towards science.
Nurulazam, Rohandi, & Jusoh (2010) emphasized the significance of affective domain in science education and quoted Shulman and Tamir (1973) that:

The affective outcomes of instruction are as important as the cognitive outcomes. The affective domain is characterized by a variety of constructs, such as attitudes, preferences, and interests. But negative attitude towards a given subject leads to a lack of interest and avoidance of the subject. (Ghafoor & Shilna, 2014, p.66).

Nurulazam et al. further described that a positive attitude towards science can generate a positive commitment to science that will eventually influence the life-long interest and learning of students in science. Whereas, a negative attitude towards a certain subject can make learning or future learning problematic.

Yara (2009) revealed that attitude towards science represents feeling or interest towards learning science. Furthermore, attitudes towards science are the learner’s disposition towards liking or disliking science. Erdemir (2009) also provided the opinion that students can be successful in science subject provided they have attitude towards science.

Numerous studies have found that teaching methodologies effect the attitude of students towards science (Adesoji, 2008; Gok and Sılay, 2008; Erdemir, 2009) and also predict achievement (Siegel, & Ranney, 2003; Erdemir, 2009; Hegarty-Hazel, 1990; Schibeci & Riley, 1986; Simpson & Oliver, 1990). Siegel, Ranney (2003) stated that specifically activity based science instruction (Fraser, Aldrige, Adolphe, 2010; Freedman, 1997) and problem solving science instruction (Iskandar, 1991; McComas, 1996) have been found to increase positive attitudes towards science. Therefore, teachers can use various hands-on activities and different teaching methods to develop positive attitude toward science among students (p.758).

Iqbal, Azam, & Rana (2009) emphasized that the:

Role of science education in the socio-economic development of the societies and nations hardly needs any arguments or discussion. It is because of this
realization that science education has found a secured place in school curricula in almost every country around the world, particularly since the last few decades. However, what kind of science should be taught at different levels and how to teach it has been evolving over a period of last few decades.

(p 29)

Normah & Salleh (2006) have described that in daily life scientific concepts are being used but these concepts are complex and difficult in nature. Therefore, interest and attitude towards science can play a significant role among students studying science.

According to Craker (2006), “attitudes are learned, not inherited. The attitudes toward science change with exposure to science, but that the direction of change may be related to the quality of that exposure, the learning environment, and teaching method” (p.1). Peker, Mirasyedioğlu (2008) quoted Dede (2006) that with the student centered approach, attitudes especially towards science can be acquired. Therefore, recognition of students’ attitudes can be helpful in making interests and curiosity lively and increasing student’s success.

Osborne et al. (2003) as quoted by Shah and Mahmood (2011) found that there are various components of attitude towards science which have been discussed by several researchers (Salta and Tzougraki 2004; Morrell and Lederman 1998; Ramsden 1998; Crawley & Black, 1992; Myers and Fouts 1992, Koballa, 1988; Oliver & Simpson, 1988; Frazer and Walberg 1981, Gardner, 1975) either by qualitative method or quantitative method. Osborne et al. (2003) described that attitude comprises of several sub-constructs which eventually lead to an individual’s attitude towards science.

Siegel and Ranney (2003) emphasized that the efforts are being done to increase students’ attitudes towards science, enhance interest, performance, and student’s retention in science (Third International Mathematics and Science Study, 2001). Attitude towards science also remained researchable in other disciplines like computer science and university sciences.
Mattern and Schau (2002) stated that, “In developed countries, it has been determined that goals of science are never fully realized, that students do not like science lectures and that most have no preference for science”. Attitudes not merely affect views of science and ambitions for future careers, they can also influence achievement. Therefore, the significance of “attitude towards science” can be acknowledged from the findings of the research showing positive relationship of attitude towards science and achievement, increase enrollment in science courses, achievement in science and interest in scientific careers (Carey and Shavelon, 1988). It is also proved from researches that students having more positive attitude towards science have long last learning and they want to continue with those subjects they enjoy (Pell & Jarvis, 2001; Norwich and Duncan 1990).

Nearly all researchers agreed that negative attitudes towards science are critical problem for science education (Ramsden, 1998) therefore, researchers proposed that to solve this problem, studies regarding attitude towards science and science learning must be conducted. The learners, showing more positive attitudes toward science demonstrate enhanced attention to classroom instruction and contribute more in science activities (Germann, 1988). However, there are certain studies which reported modest positive correlations between science attitude and science achievement (Schibeci & Riley, 1986; Keves & Morganstern, 1992).

Due to its significance, attitudes of students towards science at elementary as well as secondary level have been measured exclusively, out of which Gardner (1975) is on the top of the list. Other researchers such as Fraser and Walberg (1981); Banu (1986); Shukla (2005); Vodopivec, Vujaklija, Hrabak, Lukic, Marusic (2002); Adesoji (2008); Lakshmi (2004); George (2006); Caleon, Subramaniam (2005) have either done research qualitatively or quantitatively regarding attitude towards science.

Weinburgh (2000) found that over the past 30 years, trend has been increased to measure attitude towards science. Therefore, in order to measure attitude towards science from various perspectives, a range of instruments have been developed and published from various dimensions. Many factors/ sub-constructs have been linked
with attitude which sometimes created vagueness instead of clarity to the understanding of the construct (Koballa, 1988).

2.2.11 Scales on Attitude towards Science

Several scales are available in the literature regarding attitude towards science. Here is the detail of some of them.

Anwer, Iqbal, and Harrison (2012), examined students’ attitude towards science in Pakistan. They administered ‘‘Test of Science Related Attitudes’’ (TOSRA) developed by Fraser (1981). Shah & Mahmood (2011) stated that review of the psychometric properties and structure of some of the commonly used instruments to measure attitude towards science is beneficial for the measurement of ‘attitude towards science’. Shah & Mahmood (2011) adapted an attitude scale developed by Renmin, Raymonan, Susan and Hanexia (1998).

Malik, Shah, Iqbal, and Rauf (2010) developed an ‘attitude towards science learning scale’ in Urdu language. There were four subscales of it, namely, enthusiasm in science learning, feeling pleasure, teacher interaction, and disliking science subject.


Besides these extensively used instruments, certain published instruments are also available which have been used by the numerous researcher only once in their studies. These instruments include attitude towards science scale by Parkinson,
Hendley, Tanner and Stables (1998) and Mahmood and Kono (2004). Martin-Dunlop and Fraser (2008) measured Perceptions of the learning environment, attitudes towards science, and understandings of the nature of science among prospective elementary teachers in an innovative science course. Germann (1988) developed and validated the ‘Attitude toward Science in School Assessment’ (ATSSA). George (2000) developed a questionnaire for data collection concerning student’s attitude towards science. Johnston (1997) developed a tool and focused on five dimensions reflecting the inter-relationship between affective, behavioral, and cognitive attitudes to science. Test of Science Related Attitude (TOSRA) was developed by Fraser (1981) has been used in many studies e.g. Rana (2002) has translated in Urdu language in Pakistani and used it in a study to explore students attitude towards science.

Smith, Walker, and Hamidova (2012) did a structural analysis of attitude towards science scale (ATS) scale (Francis & Greer, 1999). The instrument contained 20 items on a 4 point Likert-type scale. A close reading of the final 20 items on the ATS scale suggested that many of these items expressed independent belief statements that were interwoven with attitudinal statements.

Bryan, Glynn and Kittleson (2011) explored the motivation of students (14–16 years old) to learn science in their introductory science courses and used a research tool consisted of self –efficacy, intrinsic motivation and self-determination. Pell and Jarvis (2001) developed attitude to science and school scales with sub-scales measure 'liking school', 'independent investigator', 'science enthusiasm', the 'social context' of science, and 'science as a difficult subject' .

Serin, Mohammadzadeh (2008), examined the relationship between primary school students’ attitudes towards science and their science achievement by using “Science Attitude Scale” developed by Baykul (1990). Weinburgh (2000) studied the changes in attitudes toward science of African-American fifth grade students. The ‘Attitudes toward Science Inventory (ATSI) was adapted and designated ‘Modified Attitudes toward Science Inventory ‘(mATSI).
Liaghatdar, Soltani, and Abedi (2011) developed a scale to measure attitudes toward science among Persian secondary school students. The research instrument was, translated Persian version of Simpson – Troost Attitude Questionnaire (STAQ). The scale is multidimensional and the dimensions have sufficient reliability and validity for measuring attitudes toward science.

### 2.2.12 Implications of Attitudes In Science Teaching And Learning.

According to Soomoro, Qasirani and Uqaili (2011), attitudes are formed through knowledge and can be changed through assessment using variety of techniques and attitudes change gradually. Akinbobola (2009) described that individuals continuously develop new attitudes and change the old ones when they are exposed to new experiences and information.

Abell and Lederman (Eds.)(2007) described that deep scientific knowledge yields from participating actively in science in a structured learning environment. Teacher must imply teaching strategies that help learners distinguish inconsistencies and conflicts in their thinking as these experiences promote the construction of new and more coherent knowledge (Staver, 2007). Many research studies revealed that inquiry activities results in positive interest in science and motivation to study science. Gibson and Chase (2002) reported that through inquiry activities interest in science is developed and persisted for long period of time. The studies regarding attitudes in science education (attitude towards science) are of concern mostly to elementary, middle and high school students and college student (Turkmen, 2007, George, 2006)

Although many researches on attitude towards science dealt with science in general, however, there are certain researches that explored this concept in specific science courses as biology, chemistry (Howe and Durr 1982; Bennett 2001a,b), or physics ( Krogh and Thomsen, 2005).
Summary

Attitude may be described as a mental state, more or less enduring, representing an inclination to react favorably or unfavorably towards a selected class of stimuli. In science education, the development of positive attitude towards science, science learning and has always been concerned. Attitude can be measured by direct techniques such as semantic differential scale, Thurston Scale, Likert scale and Guttman Scale. The indirect techniques are projective techniques, interviews and many more. The Likert scale has been used in research frequently because it is easy to construct and score. Attitudes are anticipated to change as a function of experience. Moreover, exposure to the 'attitude' objects may have an effect on how a person forms his or her attitude. The repeated exposure of the individual to a stimulus is a sufficient condition for the enhancement of attitude towards it. Attitude and attitude change can be evaluated through personal diaries, self-report scales, personal interview, drawings, photographs and physiological expression, such as facial expressions, gestures and personal posture. Attitudes are learnt in a society, attitudes are affected by group norms, attitudes are interlinked and attitudes determine the behavior. Gardner has distinguished attitude towards science and scientific attitudes as “attitude towards science is linked with the views and images that an individual develops about science as a result of interaction with different situations, while the term scientific attitude is linked to the ways of thinking or scientific method, which covers the skills and is related to the undertaking of practical work”. There are various constructs of attitude science scales. Some of famous scales to measures attitude towards science are TOSRA, ATS-I and ATS-II. Similarly there are many constructs of scientific attitudes including curiosity, rationality, and willingness to suspend judgment, open-mindedness, critical mindedness, objectivity, intellectual honesty, and humility. Researchers have described that attitudes have three elements i.e affective, behavioral, and cognitive. Johnston have presented a “tripartite view” of attitudes based upon the Hovland's Learning Theory Model. There are many educational implications of attitudes in science education. Attitudes can influence learning and hence, have impact on the academic achievement of
learners. Attitudes can also be used to predict the success of learner in educational settings.

**PART-III**

**2.3 PSYCHOLOGICAL BASIS OF THE RESEARCH**

The current section is related to the constructs of this study and provides the psychological basis of the study. This psychological basis will help in describing the rationale of the study. This section is further divided into two sections i-e Field-Dependent/Field-Independent cognitive style and Convergent /Divergent cognitive learning style.

**2.3.1 Field-Dependent /Field-Independent Cognitive Style**

It is evident that individuals having different learning styles but participating the identical learning activity perceive experience in a different way. They develop dissimilar understandings in relation to the experience and after separating from that experience they learn dissimilar things. Every individual learns and perceives according to his/her unique learning style. Each style has certain strengths as well as certain weaknesses.

There are only few numbers of styles which could get the attention of researchers and Field-Dependent (F.D) / Field-Independent (F.I) are one of the most well researched cognitive styles in the history (Chapelle 1995; Chen, 2002; Lusac-Stannard, 2003; Messick 1976a, 1976b; Witkin et al., 1971; McKenna, 1990, 2006 online; Musser 2002; Wyss 2002). Over the years several research studies (Al-Naeme , 1991; Johnston, Al-Naeme, 1991; Bahar and Hansell, 2000; Danili and Reid, 2004, 2006; Tsaparlis, 2005; Tinajero and Paramo, 1998; Johnstone, Watt and Zaman, 1996 etc.) relating to the construct of Field Dependence-Field Independence have been published.
According to McKenna (1990, 2006 online) F.D/F.I dimension not merely includes cognitive and metacognitive elements but also the socio-affective aspect of the learner. Field-Independent (F.I) learners may be ignorant of the cultural or social context of an experience. However, Field-Dependent (F.D) learners may be very sensitive to the cultural or social context but oversight essential particulars while learning.

The construct of F.D/F.I was originated by Witkin (Witkin et al., 1974; 1975; Witkin and Goodenough, 1980; Goodenough, 1986). In 1950s, Herman Witkin led most of his novel research in this learning style (Feist, 2012, Fyle 2009; Lucas-Stannard, 2003). In 1975, the educational implications were proposed by Witkin, Moore, Goodenough, and Cox. In the original test, the Body Adjustment Test and the Rod and Frame test were used. Similarly, the Embedded-Figures Test identifies an individual’s Field-Dependence/ Field-Independence on the basis of the time they take to identify a simple figure in a more complex visual field. Field-Dependent consumed extra time identifying the figure whereas, Field-Independent individuals identified the figure rapidly.

Witkin and Goodenough (1980) investigated personality in relation to the integrative process of making contact with the environment through perception and called it the ability to conduct “abstract cognitive operations” on the material that receives focus (Witkin et al., 1975). Witkin and Asch (1948a, 1948b), Witkin (1949; 1950) revealed “some individuals consistently tended to attend to different type of cues. Subjects who used visual cues were designated ‘field-dependent’, while those who used postural cues (such as tactile, and kinesthetic cues) were designated ‘field-independent’”. The work of Witkin was focused on estimating to what degree the perception of an individual regarding an object was affected by its surrounding field. Witkin intended to find if “some people saw the tree, while others saw the forest”. Witkin explained that, “where field-dependent people see the forest, field-independent learners see the tree within the forest” (Ehrman 1997; Maghsudi 2007; Soozendhfar 2011). Soozendhfar (2011) described that “Field independence (F.I)
addresses the degree to which an individual focuses on some aspects of experience and separates it from its background”.

Ehrman and Leaver (2003) described that in literature, the terminology “field dependence” has been used in two ways i.e lack of the kind of discrimination and awareness of the entire field. MacKeracher (2004) quoted that, "field- independence and field-dependence are two opposing cognitive behaviors that serve the same function – to allow the individual to select from and make sense of the potentially overwhelming tumult of experiences and information that bombard us daily (Witkin, Moore & Goodenough, 1975)”. The F.D/ F.I dimension in learning styles is related to the ability to overcome an embedding text which appears distinct from the distracting fields (Zhang, 2013).

Brown (2000) has defined field independence as the ability to:

Perceive a particular relevant item in a field of distracting items. He defined field dependence as the tendency to be ‘dependent’ on the total field so that the parts embedded within the field are not easily perceived, although that total field is perceived more clearly as a unified whole.(p. 115)

2.3.1.1 Field Independence and Field Dependence. According to Witkin et al., (1977) as quoted by Liu, Ginther (1999), F.D/F.I model is a bipolar, value-neutral and is characterized as the ability to distinguish main elements from a “distracting or confusing background”. The mode of perception of F.I is strongly unaffected by the surrounding field whereas, the mode of perception of Field-Dependents is largely effected by the surrounding field.

2.3.1.2 Characteristics of F.I/F.D. There are several characteristics of Field-Independent and Field-Dependent. Fyle (2009) and Zaman and (1996) have described some significant features of these two learning styles.

2.3.1.2.1 Restructuring skills. Fyle (2009) revealed that F.D/F.I demonstrate how well individuals are skilled of restructuring information using significant hints and arrangement of field (Weller, Repman, & Rooze, 1995). F.I individuals are
capable to provide structure and organize information on their own (Myers and Dyer, 2006).

According to Witkin as quoted by Lucas-Stannard (2003):

The individual, who, in perception, cannot keep an item separate from the surrounding field—in other words, who is relatively Field-Dependent— is likely to have difficulty with that class of problems...where the solution depends on taking some critical element out of the context in which it is presented and restructuring the problem material so that the item is now used in a different context. (p.1977)

Field-Independent individuals learn or remember significantly more than Field-Dependent under some conditions for example, intrinsic motivation and discrimination learning, when non salient cues are relevant (Lucas-Stannard, 2003)

Musser (1998) as cited by Behnam, Fathi (2009) emphasized that nowadays the assessment of higher order thinking of students is getting popularity. Daniels (1996) as quoted by Altun and Cakan (2006) described that field-dependent individuals depends on “perceptual field surrounding” and have difficulty for paying attention, taking out, and using non prominent clues.

Lu & Suen (1995) as quoted by Vacas, Pérez, Couñago, Fernández (2011) that performance of Field-Independent learners is better on unstructured tasks than that of F.D learners. Goodenough and Karp (1961) and Witkin and Moore (1974); Korchin (1986) described that there are two cognitive related restructuring skills of F.I individuals more than F.D, these are breaking up an organized complex field into its essential elements and providing a structure to field that is deficient of it, or imposing a different organization on a field to that which is suggested by its in-built organization (Danili and Reid, 2006; Zaman 1996). Tinajero and Paramo (1998) cited Frank and Nobel (1985) that field-independent individuals are more autonomous, successful and have greater skills in tasks which involve these cognitive
restructuring skills (Zaman, 1996, Liu, Ginther, 1999). Field - Dependent (F.D) learners can inadequately isolate an item from its background (Danili and Reid, 2004).

Witkin and Goodenough (1980) suggested that field-dependent/independent could be considered as way of processing information from a more computed field. Sowder (1985) as quoted by Alamolhodaei (2009) stated that “the cognitive restructuring aspect of field dependence/independence is found to be related to problem solving ability”. It means that students with a high score on cognitive restructuring tasks are better problem solvers than students scoring low in such tasks (Zaman, 1996).

2.3.1.2.2 Stability. Witkin (1976) found that the F.D/F.I cognitive style is stable with age. “Individual differences in the expressions of articulated functioning in a field are related to expressions in other fields and will not change for months and years”. Goodenough (1976) stated that the individuals who are analytical in one perceptual background tend to be analytical in other perceptual backgrounds and problem solving situations (Zaman, 1996). Musser (2002) has described that “age” factor has an effect on field dependence-independence. Kids are usually Field-Dependent, but as they become adults, their field independence rises. Grown up learners are more F.I (Gurley, 1984 as cited by Sisco, Leventhal, 2007). Afterwards, field independence progressively decreases all through the rest of life, with elder persons likely to be more F.D than their younger followers (Witkin et. al., 1971).

2.3.1.2.3 Global and analytical approaches. Witkin et. al. (1977) revealed that F.I individuals are associated with analytic domains e.g. sciences because these require greater use of restructuring skills therefore, F.I individuals are more analytical in the way they perceive the world (Myers and Dyer ,2006). Summerville (1999) as cited by Maghsudi (2007) referred the field dependence and field independence as global versus analytical style that reflects the “degree to which an individual’s processing information is affected by the contextual field (p. 3)”. Hall (2000) described that F.I individuals are being considered as “analytical, competitive, individualistic, task oriented, internally referent, intrinsically motivated, hypothesis
testing, self-structuring, linear, detail oriented, and visually perceptive (p. 5)”. On the other hand, F.D individuals are being considered as “group-oriented, global sensitive to social interactions and criticism, extrinsically motivated, externally referential, not visually perceptive, non-verbal, and passive learners who prefer external information structures (Hall, 2000, p. 6)”.

Handal and Herrington (2004) quoted Governor (1998) that F.D learners require more external help and social input in interpreting clues embedded in a particular learning task. Hu (1998) as quoted by Angeli (2013) found that F.I learners were more analytic and rely less on external clues than their F.D counterparts. Field-Independent learners are more able to generate and structure their own knowledge rather than accepting knowledge reprocessed by others. F.D has a global perception of the world which often enables them finding it more difficult to solve problems (Myers and Dyer, 2006, Ronning et al., 1984).

Witkin (1974) as quoted by Zaman, 1996 stated that the individual differences can be conceived as an analytical field approach at one extreme and global field approach at the other and “the capacity for analysis and structuring” of experiences is the core of field dependence/independence learning style. F.D observes the world in a global way, while F.I looks it analytically (Heywood, 2005; Mariani 1996). Witkin (1977) further indicated that the learner with an analytical style is more likely to be analyzed a field when the field is organized (Zaman, 1996; Mariani 1996). While the learner with a global style is more likely to perceive a field as it is without analyzing and structuring it. Field independent students are good in performance in problem solving tasks when the solution depends on using an object in an unfamiliar way than are the Field-Dependent.

Barrett And Thornton (1967) described that several studies have shown that F.I individual tend to be logical, analytical and well articulated in being able to extract essential aspects from problems for analysis. While, the F.D individuals were more global in outlook and less able to extract the essentials elements of a problem. Zaman (1996) concluded that Field-Independent individuals, approach tasks analytically and the Field-Dependent individuals approach them in a global way, instead of in parts.
Al–Naeem (1991) stated that “field-independent subjects to be more self-sufficient than field-dependent”. Several studies have shown that the difference between F.D and F.I individuals is same to that of difference between Holists and Serialists (Jonassen & Grabowski, 1993; Riding & Cheema, 1991). F.D individuals normally look the global picture while neglecting the details, and perform the task more holistically. Field-Independent individuals likely to differentiate “figures” as being isolated from their background, concentrate on details, and be more serialistic in their ways to learning.

2.3.1.2.4 Social orientation. Goodenough (1976) described that Field-Dependent individuals give more consideration to the significant social aspects of their environment while Field-Independent individuals give less consideration to social clues except there is some particular reason for the attention (Zaman, 1996). Altun and Cakan (2006) described that F.D individuals are better at remembering social information such as relationships and conversation. Field-dependent are normally more social in their nature (Myers and Dayer, 2006). According to Witkin Field-Dependent learners prefer group work whereas, individual work is prefered by Field-Independent leaners (Lucas-Stannard, 2003).

Literature reveals that there exists a strong association between social interaction and F.D/F.I cognitive style. Field-dependent individuals are considered as very social and can express their feelings openly. They have been considered as very friendly, warm, and pleasant. Witkin et al (1977) and Goodenough (1986), described that F.I learners are described as impersonal and task-oriented. Researches revealed a strong correlation between gender and field orientation. Women are most probable field-dependent, whereas, men are normally field-independent. Similarly there exists a close alignment in field dependence/independence and job descriptions. In a highly structured environment, the performance of Field-Dependents is low. In assessment, the performance of Field-Dependents on open-ended questions is not so good compared to field-independents (Encyclopedia, 2013).
2.3.1.2.5 *Concept attainment.* Zaman (1996) examined many researches and suggested that Field-Independent individuals obtain information more efficiently, rely less on guessing with inadequate information and are more ready to accept the irrelevance of concept attributes than are Field-Dependents.

Goodenough (1976) stated that “Field-Independent learners are generally better than Field-Dependent learners in concepts attainment tasks” and would learn concepts more quickly. While Field-Dependent subjects may demonstrate greater readiness than Field-Independent when relevant attributes and non-salient cues in concept definition.

2.3.1.2.6 *Working memory.* There is difference in the effective use of working memory of Field-Dependent/independent individuals. There exists a relationship in the efficiency and performance in working memory tasks to field dependence/independence. Field-Independent individuals are better in the information recalling stored in the working memory than Field-Dependents (Pascual-Leone 1974, Case and Globerson 1974; Frank, 1983, 1984; Zaman 1996; Daniels 1996; Altun and Cakan 2006). For F.D, it is difficult to retrieve the information from the long-term memory. Contrary to this F.I can retrieve the information from memory more efficiently.

2.3.1.2.7 *Information processing.* According to Wang, Wang and Ren (2003) there is difference between F.I and F.D learners in solving complex problems of Dynamics. For F.I learners, it is easy to form a clear map of motion as compared to F.D learners. Hall (2000) pointed out F.I and F.D learners are different in information processing. There exists difference in between F.D/F.I, “varying information processing skills such as selective attention, short-term memory encoding, and long-term recall at which Field-Independent individuals are more accurate and efficient” (p.72). Researchers found that there is difference in the information processing and effectiveness of Field-Dependent/ Field-Independent individuals (Davis and Frank 1979; Davis and Cochran 1989; Frank and Keene, 1993).
2.3.1.3 Factors Affecting Field Dependence-Field Independence. The following are some factors that may have an effect the degree the individuals are either F.D or F.I.

2.3.1.3.1 Brought up. Musser (2002) quoted that Witkin believed that the parental control in the brought up of child affects field dependence-independence tendencies (Korchin, 1986). Witkin’s study of “child nurturing” revealed that children are more likely to be F.D where much importance is on the respect to parental authority and external control of desires. Whereas, children are likely to be F.I when they are being encouraged to develop and function autonomously.

2.3.1.3.2 Socioeconomic status. Musser (2002) revealed that literature provides certain evidences that socioeconomic status may influence field dependence-independence. Children’s with various socioeconomic classes scored significantly different relating to the field dependence-independence variable (Forns-Santacana, Amador-Campos, & Roig-Lopez, 1993).

2.3.1.3.3 Gender. Musser (2002) and Pithers (2002) found mixed confirmation regarding the effect of gender on field dependence-field independence. No significant difference has been found in the studies of children however, in the studies of adults (Desanctis & Dunikoski, 1983; McRae & Young, 1988, Murphy, Doucette & Kelleher, 1997; Murphy and Casey, 1997; Wieseman et al, 1992). Males tended to be field independent. Very limited research is available showing consistent gender differences in the scores of F.D-F.I, especially in science, engineering, business studies, and education (Wieseman et al, 1992). Tinajero & Paramo, (1998) found that the performance of both F.I male and female were better than Field-Dependents in all subjects. However, Goldstein & Blackman, (1978) cited that Witkin also revealed a mild but persistent difference among the genders (female tended to be field dependence).

2.3.1.4 Instruments to Measure F.D/F.I. Fyle (2009) reported that in order to measure field dependence and field independence “numerous instruments have been devised (Riding, 1991; Peterson, Deary, & Austin, 2003; Witkin, Oltman,
Raskin, & Karp, 1971)” (p.8). In the research studies, the most frequently used instruments to measure field dependence–field Independence are: Cognitive Style Analysis (Riding, 1991), the Group Embedded Figures Test (GEFT) (Witkin et al., 1971) and Embedded-Figures Test (EFT). The tests to measure spatial perception include “Rod and Frame Test” (Witkin et al., 1962), “spatial visualization” such as GEFT (Witkin et al., 1971) and “Hidden Figure Test” (French, J. W., Ekstrom, Price, L. A., 1963) categories which also measure field dependence/independence (Jonassen & Grabowski, 1993). GEFT was the sole nonverbal, simplest, and mostly used instrument to determine learning styles because very limited level of language skills are required to perform the tasks. Moreover the psychometric properties of GEFT have been examined in cross-cultural settings and recognized as very much reasonable (Cakan, 2003; Witkin, Oltman, Raskin, & Karp, 1971). The Embedded-Figures Test (EFT) is based on time an individual takes to identify a simple figure from a more complicated field and it determines an individual’s field Dependence-Field Independence (Witkin et al., 1977). Majority of individuals fell on the continuum between being completely F.D or F.I (Myers and Dayer, 2006; Lucas-Stannard, 2003). Researchers have found that in science oriented courses, the performance of F.I was better than F.D (Danili & Reid, 2006; Kali & Orion, 1996; Kang, Scharmann, Kang, Noh, 2010; Mancy & Reid, 2004). Kali and Orion (1996) explored geological spatial ability among school students and revealed that learners having penetrative characteristic (a F.D characteristic) obtained higher scores as compared to those who have non penetrative characteristic (a F.I characteristic).

2.3.1.5 Advantages and Disadvantages of Filed Dependence-Field Independence. According to Fyle several researchers (such as Jones, 1993; Schmeck, 1988) have signified that learners must have style awareness and their positions on the F.D/F.I dimension. However, very limited research has been conducted regarding this. Fyle emphasized that the style awareness empowers the students to use the best strategies while learning from hypermedia environments. Sadler-Smith and Smith (2004) have recommended that F.D students must be provided a “structured route through learning” while for F.I a “global perspective of the content” must be presented (p. 409). This factor is important in hypermedia
learning environments as the instructor is not always there to guide the learner through instruction (Chen & Macredie, 2002; Dufresne & Turcotte, 1997; Shih & Gamon, 2002).

Kang (1999) as quoted by Wyss (2002) has also described that awareness of relative learning style of learners can improve their learning power and nurture their intellectual growth. Likewise, instructors can recognize the most prevailing style patterns of their learners and can develop lesson plans to accommodate individual learning style preferences.

According to Hansen (1995) majority of the cognitive style studies have focused the differences of cognitive styles of students pursuing different majors either in a four year institution or in a two year institution. Hensen further described that Witkin, et al. (1977) initially conducted a longitudinal study of ten years in four year institutions which pursued to determine if field dependence/independence was related to a student's “(1) initial major choice (science, education, and other) and final degree major and (2) achievement in various major courses” (p.19). It was found that cognitive style of students influenced the selection of a major. The students had changed their initially selected major because that demands a specific cognitive style different from their own cognitive style. Therefore, students decided to choose a major which complemented their cognitive style. The study also revealed that the compatibility of cognitive style yields higher grades. Frank (1986) emphasized that the cognitive research must be used in order to improve the instruction. Many researchers have claimed that the location of an individual on the continuum between the two poles contributes to academic choice, success and vocational preference (Witkin, 1976).

2.3.1.6 Educational Implications of Field-Dependents and Field-Independents. Heywood (2005) suggested that in any program, diversity of learning styles must be designed to accommodate students of different personalities. Tyler (1978) had emphasized that in higher education teachers should have awareness of their learning styles.
According to Bertini (1986) as quoted by Musser (2002), Witkin was concerned that there must be compatibility between instruction and with the individual’s cognitive styles. Witkin took initiatives regarding the “possibility of producing change, flexibility and mobility in cognitive styles” with the help of suitable training procedures e.g. for such F.D individuals who usually avoid mathematics, different kinds of methods and approaches must be used in accordance with their cognitive style by such teachers whose cognitive styles and teaching methods are similar to F.D students.

According to Wyss (2002), the performance of Field-Independent learners in such classrooms which includes analysis, consideration to details and become skilled of drills, exercises, drills and other focused activities. While Field-Dependent learners achieve high scores in everyday language situations and in those tasks which require interpersonal communication skills.

McKenna (1990, 2006 online) emphasized that cognitive style researches give us a rationale for identifying individual weaknesses and suggested that the ideal balance is somewhere in the center of the F.D/F.I continuum.

According to Johnstone (1991) as quoted by Zaman (1996) individual differences in learning and teaching any subject matter is one of the most striking phenomena. The field-dependence/field-independence cognitive style, and its effects upon the performance, differences in learners and its learning implications with special reference to science learning are discussed and accepted as a significant concern in the development of instructional material. When this is linked with a predictive model of learning science, interesting relationship emerges.

2.3.1.7 Implications of Field-Dependent and Field-Independent Learning Style. Musser (2002) has described following implications of Field-Dependent and Field-Independent learning styles.
2.3.1.7.1 Affective skills. Several behavioral studies have shown that Field-Independent individuals are less impulsive and straight in their expression (Korchin, 1986, p. 49).

2.3.1.7.2 Motor control. In “Motor Inhibition”, studies which demand individuals to accomplish a “simple and familiar action as slowly as possible”, Field-Independent individuals control their behavior in a better way. Studies have also revealed that hyperactive children are usually fielded dependent.

2.3.1.7.3 Neurological implications. Korchin cited that studies have shown that F.I individual has more control over their personal defenses. F.I prefers intellectualization, loneliness, and prediction; on the other side, the F.D tends to use renunciation and suppression. Likewise, F.D individuals tend to forget their dreams, particularly stressful dreams (p.51).

Pithers (2002) considered that self-awareness of “information processing style” or cognitive style is not only a significant issue in developing more successful organizational managers (Murphy, Doucette, Kelleher, Young, 1997), it is also significant for developing successful teachers as educational leaders.

2.3.1.7.4 Social implications. Generally, in order to seek information, F.D individuals have a tendency to look other people whereas, F.I individuals look within themselves. Studies revealed that F.D people prefer social interaction. According to Witkins’s differentiation theory, F.D/F.I dimension influences our personalities i-e F.D have more interpersonal skills than F.I.

2.3.1.8 Implications of Field Dependence/Independence for Science Learning. According to (McGee, 1979; Scarr & Carter-Saltzman, 1982; Yen, 1975) as quoted by Fyle (2009), field dependence/independence has significant implications for learning science as its positive relationship has been found with “spatial-ability construct”. Consequently, a high spatial ability is linked with high performance in mathematics and science (Lord & Rupert, 1995) and for mechanical tasks (Harris, 1978).
Linn and Peterson (1985) have defined “Spatial ability” as a skill in “representing, transforming, generating, and recalling symbolic, nonlinguistic information” (p.1482). Linn and Peterson have described three different aspects of spatial ability:

1. Mental orientation: “A gestalt like process that entails rotating a two or three dimensional figure rapidly and accurately
2. Spatial perception: involves individuals being able to determine spatial relationships with other to the orientation of their own bodies, in spite of distracting information
3. Spatial visualization: it involves engaging in complicated, multistep manipulations of spatially presented information that are distinguished by the possibility of multiple solution strategies. (Linn & Peterson, p.1482)

Several researchers reported the better performance of F.I students studying science-oriented (Danili & Reid, 2006; Kali & Orion, 1996, Orion, Ben-Chaim, Kali, 1997; Kang et al., 2004; Mancy & Reid, 2004).

Danili and Reid (2006) explored relationship between F.D/F.I, convergent/divergent styles, and achievement in chemistry. A positive correlation was found between field dependence/independence and student’s performance in chemistry tests. On the whole, the study revealed that the performance of F.I students was better in chemistry tests. Mancy & Reid (2004) explored the influence of field independence/dependence upon the performance of first year university students studying science and found positive relationship in exams of F.D/F.I. The scores of F.I were higher than F.D students. It was recommended in the study that in science learning, F.I style must be considered especially for such topics which require spatial skills. Similarly the learning of F.D may be increased with the application of additional learning strategies. Fyle described that for learning science; the F.D/F.I construct is significant because it has ability to highlight the degree to which students can process analytical, spatial, and abstract content. It was also emphasized that in science learning, field-independent style must at least be considered especially in certain domains and topics that require spatial thinking skills. The results revealed significant correlations for both the written and practical examinations. On average, the examination scores of F.I students were higher than F.D students.
Chen & Macredie (2002) found that researches have explored field dependence/independence and its effects on hypermedia learning. Certain themes such as learner control, non linear learning, navigation strategies, learning effectiveness and dis-orientation, matching and mismatching were also studied.

2.3.1.9 Teaching Strategies for F.D/F.I. According to Jonassen, Grabowski (2012), graphic organizers are tools for organizing science information to help make concepts easier for different types of learners. There are various styles and they are concept driven. They are very helpful to the Field-Dependent learners. Some graphic organizers include charts, tables, graphs, concept maps, and different types of webs, T-charts, KWL charts, and many others.

Graphic organizers can aid all learners to organize, analyze, and reflect upon science concepts. These have been extremely effective in helping the Field-Dependent learner to focus on key patterns and issues, to look at background information that is normally missed, and to ask questions that lead students to discover properties or qualities (Jonassen & Grabowski, 1993).

Lee et. al (2005) found that recent studies on cognitive style revealed that the performance of Field-Dependent students is best with socially oriented learning tasks such as cooperative learning style whereas, Field-Independent students work on abstract and less socially oriented assignments (Saracho, 1998a,b). Several other researches indicated that learning is significantly more effective in matched conditions as compared to learning in mismatched conditions. Lee, Cheng, Rai, & Depickere (2005) quoted Witten (1989) and Ford (1995) that the performance of F.D students was equivalent to F.I students in a matching teaching method. On the other side, F.D learner performed poorly when taught with a contrasting method.

Science teachers can use several strategies to enhance the skills of F.D students. Well-organized, structured materials help to enhance the understanding of F.D learners. They can use constructivist method, process-inquiry methodology, puzzles and board games, and computer games, organizers for science lessons, concept maps, and process skills (Martin, 1998).
Hayes & Allison (1998) as cited by Guisande, Páramo, Tinajero and Almeida (2007) emphasized that cognitive learning style helps to improve learning quality. Instructors and learners need to be taught to adopt a flexible approach to cognitive style, attitudes, thinking and behaviour. The theory and research in the domain of F.D/F.I is continuously providing insight and evidence into “how individual learners prefer to attend, perceive and process information”. Moreover, it provides insights about “how they think and apply their learning” for problem solving.

According to Lee et al. (2005), cognitive style can be categorized as either F.D/F.I. Field-Dependent individuals prefer guidance in learning processes and adopt less analytic approaches to learning while F.I individuals need less guidance and employ more analytical and self-sufficiency approach to learning (Chou, 2001; Oughton & Reed, 1999; Tinajero & Paramo, 1998).

According to many researchers (Chou, 2001; Liu & Reed, 1995; Tinajero & Paramo, 1998; Weller, Repman, & Rooze, 1995) F.D/F.I is one of the most extensively studied cognitive styles with the broadest application to the problems of education. Such studies have shown that there exists individual differences but individuals have consistent and preferred modes of information processing (Witkin, 1950; Witkin & Asch, 1948; Witkin & Moore, 1974).

The empirical study of Ford and Chen (2001) found that the performance and scores of students in post-test were better in matched conditions of their cognitive style. Fullerton (2000) found that F.D learners achieved less scores than F.I learners in a mismatched condition. Lee (2000) found that F.I learners likely to be internally motivated as compared to F.D learners who depend on the external force to perform a task. While the performance of F.D learners declined when engaged with such instructional strategy which was mismatched with their cognitive styles. Field-Dependent learners could score high than F.I individuals provided their preferred cognitive styles are matched. Therefore, for the effectiveness of learning, teaching style must be matched with student’s cognitive style.
Field-Independent students rely less on teacher’s guidance in developing strategies for problem solving (Myers and Dyer, 2006; Ronning, McCurdy, & Ballinger, 1984). Myers and Dyer (2006) described that as Field-dependent learners need structure and organization to be provided for them by an external source. Therefore, student-centered teaching approach and more direction on how to structure and solve agri-science problems must be adopted.

A third category, field-neutral was identified by Dyer and Osborne (1996). Myers and Dyer (2006) found that students classified as field-neutral in their learning style achieve higher scores when taught through problem solving approach rather than subject matter approach to teaching.

The performance of the F.I learners excel in such classroom learning which involves attention to details, analysis, drills, mastering of exercises, and several other activities. Whereas, the F.D learner found to achieve higher scores in everyday language situations beyond the limitations of the classroom i-e tasks demanding interpersonal communication skills.

According to Witkin et al (1977), F.I teachers are likely to use more formal teaching methods, on the other hand, F.D teachers are likely to use more frequent two-way interaction with their students. Murphy, Doucette, Kelleher & Young (1997) found that business undergraduates became significantly more F.I as they moved through their course.

2.3.1.10 Researches on Field-Dependent/Independent Cognitive Styles. Several researches have been conducted at secondary and university level to explore the relationship between field dependency/independency and academic achievement in programmes such as social sciences, natural sciences, computer science, music, arts, mathematics, and language.

In the following section, research findings on cognitive field dependency, academic achievement, and attitude studies have been discussed.
2.3.1.10.1 Field Dependency and academic achievement. Altun and Cakan (2006) noted that cognitive style has been found to be one of the important factors that may influence academic achievement of students on several school subjects (Murphy & Casey, 1997).

In the views of Tinajero and Paramo (1998), many researchers have used the F.D/F.I test a very helpful instrument to predict the academic achievement of students (e.g. Terrell, 2002). It was found that generally F.I individuals perform better than F.D individuals “whether assessment is of specific disciplines or across the board”. Research revealed that the test scores of Field-Independent learners were superior to the scores of Field-Dependent learners.

Tinajero and Paramo (1998) explored the relationship between cognitive styles and student’s achievement in several subjects including natural sciences, mathematics, social sciences; and Languages such as English, Spanish, and Galician. It was revealed that the performance of F.I students was better than F.D.

Murphy & Casey, (1997) found that the performance of F.I undergraduate students of information management program was better than F.D subjects only on one of the technical courses.

2.3.1.10.2 Field Dependency and Attitude toward computers. There are mixed findings in the literature regarding correlations between attitudes toward computers and field dependency. Fyle (2009) cited that F.D/F.I has been considered as most related to the domain of instructional design and one of the most important constructs with relevance to education especially learning in hypermedia environments because it can be used to explain and categorize the various behavior choices of learners (Jonassen & Grabowski, 1993; Messick, 1976a; Riding & Cheema, 1991; Witkin, Moore, Goodenough, & Cox, 1977). (p.7)

Abouserie, Moss & Barasi, (1992) revealed a significant correlation between field dependency and students’ attitudes. Moreover F.D students preferred to learn specific and detailed information and use the existing organization of material
provided instead of re-organizing it (Thompson, 1988, Witkin, Moore, Goodenough & Cox, 1977).

Altun (2003) explored the relationship between attitude towards computers and cognitive styles by using GEFT and found small but not significant correlations between these variables. Alomyan and Au (2004) studied the effect of students’ cognitive styles, prior knowledge, achievement motivation and attitudes on achievement in a web based environment with undergraduate university students. Finding revealed no differences between students’ field dependency and attitudes toward web based learning.

Daniels (1996) found neither any correlation between multimedia selections and field dependency, nor a predictive relationship between selection of presentation mode and field dependency.

2.3.1.10.3 Sciences. According to Myers and Dyer (2006), most of the studies and reports conducted on the learning styles revealed that the enrolled students in colleges or agriculture courses tend to be F.I learners (Cano 1999; Cano & Garton, 1994; Torres & Cano, 1995; Whittington & Raven, 1995). Druyan and Levin (1996, online 2001) suggested that “sociocognitive transaction is an appropriate learning environment in the subject of physics for F.D/F.I learners” (p.831).

Karacam and Yuruk (2009) investigated the effects of F.D/F.I cognitive styles and motivational styles on students’ conceptual understanding of physics concepts measured by different assessment techniques. The study suggested to use multiple formats of assessment tools to withdraw the confounding influence of cognitive styles on students’ scores measured by different assessment tools.

Several researchers have found that F.I learners may sometimes be better at solving agricultural course problems (Torres & Cano, 1995 a,b; Dyer & Osborne, 1996b) and educational technology (Griffin & Franklin, 1996).
Field-Independent students were more likely to study and select vocational areas involving analytical skills such as biological sciences, chemistry, mathematics, engineering, mechanical and technical (Estadt, 1997; Garton, Spain, Lamberson, Spiers, 1999; Torres & Cano, 1994; Witkin, 1976; Witkin et al., 1977).

2.3.1.10.4 Engineering. Buckley (2007) explored the learning style differences of cadets majoring in engineering and business using the GEFT. It was found that business majors were less likely to be F.I learners than engineering majors.

According to Key (1999) many factors influence student achievement including student type of curricula, interests, attitudes, relevancy of materials, motivation and the culture of the students. Certain strategies such as cooperative learning and inquiry can enhance the learning and achievement of students in science. Other concepts may also enhance student’s achievement when addressed and used properly are congruency, locus of control, and field dependency. Lusk & Wright (1981a, b) found that engineers were, on average, more F.I than Witkin’s liberal arts normative sample. According to Zhang (2013), Barrett and Thornton (1967) found that engineers are more F.I than Witkin's standardized sample. On the basis of this reasoning, engineers can be expected to be Field-Independent.

2.3.1.10.5 Social sciences. Abdolhosseini, Davood and Mojtaba (2013), explored the relationship between scores on F.D and F.I regarding citizenship among youth. Nezhad, Shokrpour (2012) found that performance of F.D learners were better when taught by the dynamic task type technique and performance was poor when taught by the static task type technique while F.I learners performed better through the static task-type technique.

Soozandehfar (2011), investigated the effects of gender and F.D/F.I cognitive styles on the student’s speaking performance by using GEFT and found a negatively insignificant correlation between the F.D/F.I cognitive styles and the speaking scores.

Maghsudi (2007) found significant difference between F.D and F.I students in their English Achievement Test scores. Davis (2006) found that community
development extension educators favored a F.D learning style. Females were found to be more Field-Dependent. Individuals with academic backgrounds in the physical sciences were found to be more F.I.

Pithers (2002) found Business students to be ‘moderately’ F.I (Franzen, 2002; Lusk & Wright 1981; McRae & Young, 1988; Murphy, Doucette & Kelleher, Young, 1997). Pithers (2002) also found that both male and female vocational teachers of various kinds were ‘moderately’ Field-Independent. No significant difference was found regarding gender effect.

F.I/F.D model has been very helpful for predicting academic performance in many studies (DeTure, 2004; Garton, Dyer, King, 2000; Hayes & Allinson, 1997). The academic success of F.I student is greater than F.D students. Field-independent individuals process information more efficiently but may ignore the social context than their F.D. Kahtz & Kling (1999) examined F.D-F.I using computer-assisted instruction (CAI). Lusk (1998) found that some researches revealed that the F.I learners prefer to be enrolled in distance learning courses however, limited evidence that they may, on average, achieve superior academic results in these courses.

Witkin (1976; Witkin et al., 1977) found that Field-Dependent students avoid vocational and academic fields demanding analytical skills. Therefore, Field-Dependent students prefer people-oriented fields such as elementary teaching, teaching in the social sciences, counseling, sales and advertising which demand social skills to be exercised.

2.3.2 Convergent- Divergent Styles

Science is not merely a collection of facts listed in a textbook, but it is also a way of acquiring knowledge. Science uses observation and experimentation to describe and explain natural phenomena. Scientists found relations between the facts, coherent and comprehensive body of knowledge about the natural world. Science has three aspects:

a) Product i.e. a body of knowledge
b) Processes which include scientific thinking for observation, measurement, performing experiments and many others and

c) Scientific attitudes

The thinking process is very important for science process skills. The process skills are actually the skills that a scientist uses to solve problems and find answers. These are actually the same skills that we all use in our daily lives to solve problems. Researches have been done to synchronize the science curricula with the learner’s attributes such as intellectual ability, readiness, and cognitive styles. Many models have been devised to seek the process of learning. Some have identified common ways of affecting learners while others have highlighted the individual differences of learners. The information processing has offered powerful insight of learning process and it can be quantitatively verifiable. According to Heywood (2005), perhaps the “best known cognitive styles are those described on the continuum of convergent-divergent thinking” (p228.) Zaman (2006) quoted that researchers such as Getzels and Jackson (1962), Hudson (1966) and Guilford (1967) have conducted many studies regarding convergent/divergent thinking.

2.3.2.1 Convergent/Divergent Style and Creativity. Hudson (1966) has originated the idea of convergent/divergent cognitive style. According to Hudson as quoted by Graf, Lin, and Kinshuk (2008), divergent thinkers tend to be creative as compared to convergent thinkers. Such explanations initiated from Guilford’s (1954) “study of the intellect” (Zhang and Sternberg 2012; Heywood 2005). According to Guilford model, creativity and intelligence are dissimilar phenomenon. Guilford (1960) considered creativity equally important as intelligence. According to Bowman and Turnbull (2009), divergent thinking can be evaluated in numerous ways; one typical measure is known as the “alternate uses task “where persons must list down as many usages for common household objects as possible” (Guilford,1967). Convergent thinkers have a tendency to concentrate such questions which require a single answer and enjoy such test. Convergent learners tend to look for exclusive methods and exceptional solutions. In the conventional intelligence
tests, such sort of thinking is required (Santrock, 2007). Therefore, according to Hudson, convergers score better in this type of tests. Whereas, divergent thinkers dislike the limitations of conventional tests; they are more comfortable while creating several solutions. Divergers have the capacity to look for the combinations of ideas and to find the opportunities of more than one way of doing things yielding number of outcomes (Guilford, 1959a, b; Hudson, 1966). Hudson (1966) advocated that convergers are naturally attracted toward one end of the spectrum and divergers to the other end. Numerous researchers have equated convergent thinking with intelligence and divergent thinking with creativity. It has created a great deal of controversy, with several studies supporting different results (Fryer, 1996; Runco, 2008; Bennett, 1973; Nuttall, 1972). Kolb also described that divergers like observation instead of action and are emotionally-oriented and likely to be creative.

2.3.2.2 Convergent Divergent Style and Abstract Learning. It is revealed from the literature that convergent thinkers favor logical arguments and formal materials. The performance of convergers may be better than divergent thinkers on such well-structured tasks which require logical ability, whereas, divergent thinkers most probably are better in the more opened tasks as compared to convergent thinkers. The convergers enjoy correctness and logical conclusions (Guilford, 1967 and Messick, 1976; Hudson, 1966, 1967). Convergers have features like generating logical necessities, whereas, divergers have characteristics of generating the possibilities from the given information. Hudson (1966, 1967) found that divergers are highly imaginative. Convergers like to keep emotions apart from studies while divergers prefer studies involving emotions.

According to Danili and Reid (2006), “research on the Convergence-Divergence cognitive style has not received as much attention as the F.D/F.I cognitive style from educators and researchers”. Convergent thinkers obtain high scores in such problems which require one conventionally accepted solution obtained from the available information, whereas, convergers obtain lower scores in such problems which require the generation of numerous equally acceptable solutions. Contrary to this, divergent thinking deals with the capacity of making new responses,
exploring and expanding of ideas. Therefore, convergent thinking requires close reasoning whereas, divergent thinking requires flexibility and fluency (Child and Smithers, 1973).

2.3.2.3 Convergent/Divergent and Science Education. According to Alamolhodaei (1996):

Several researchers have provided support for the suggestion that science students are biased towards convergent thinking and that arts students towards divergent thinking maybe found in several studies (e.g., Runco, 1994; Webster & Walker, 1981; Sally & Bostack, 1979; Richards and Bolton, 1971; Field & Poole, 1970; Mackay and Cameron, 1968; Guilford; Hudson, 1966, 1968; Guilford, Hoepfner & Peterson 1965).(p.104)

Hudson (1966, 1967) described that convergent learners prefer to study sciences and classics, whereas, divergent learners prefer to study modern languages, arts, and history. He further discovered that “between three and four times as many convergers do mathematics, physics, and chemistry for every one tending to go into the arts”. Al-Name (1991) described that the divergers have dominance over convergers in handling the mini-projects based upon chemistry problems. Kempa and McGough (1977) as quoted by Neal (2013) identified that “students with an interest in art (divergers) tend to prefer the verbal communication mode in learning mathematics, whereas, students’ mathematical biases are found to be strongly associated with performance in the symbolic communication mode and anti-performance for the verbal mode.”

Field and Pool (1970) described that even though most of the science specialists coming to university were convergent thinkers but the achievements of the divergent thinkers were much better than convergers. Field and Pool found relationship between student’s selection of faculty (science or arts) and their convergent/divergent learning style. Guilford et al. (1965) found a positive correlation between mathematics learning and divergent thinking.
2.3.3 Researches on Convergent /Divergent Styles of Thinking

Hudson (1967) as quoted by Atherton (2013), “there were two different forms of thinking one is ‘convergent’ thinking, in which the individual is good at bringing material from a variety of sources to solve a problem, in such a way as to produce the ‘correct’ answer. This kind of thinking is particularly appropriate in science, math, and technology.”

Hudson termed the other thinking as "divergent" thinking. The divergers have skill of creative expansion of ideas provoked by a stimulus, and are more suitable for study in the humanities and artistic pursuits.

According to Bhatti and Bart (2013), several researches have revealed that learning styles can effect academic performance of students (e.g., Kolb & Kolb, 2009; Zhang & Sternberg, 2005; Snyder, 2000; Ross & Schultz, 1999; Riding & Grimley, 1999; Hayes & Allinson, 1998; Rasmussen, 1998; Tinajero & Paramo,
Moreover, Reynolds and Gerstein (1992) described that the quality of instruction can be improved if teachers and administrators are aware of the learning styles of students. Bhatti and Bart (2013) further stated that the performance of converger tends to be well in technical tasks and performance of convergers tend to be low in interpersonal relations. On the other hand, divergent thinkers perceive concretely and think reflectively and imaginatively. Divergent thinking is related to fluency, flexibility, originality, and elaboration. Divergent thinkers are likely to select the field of liberal arts and humanities. Females tend to be Accommodators and/or Divergers; whereas, males tend to be Assimilators and/or Convergers (Philbin, Meier, Huffman, & Boverie, 1995).

Zhu (2013) studied thinking styles of students and teachers and their preferences for teacher–student interpersonal behaviors. The findings of the study showed that there were divergences between thinking styles of students and teachers and the preferences of teacher’s interpersonal behavior. The study also found convergences between students and teachers as both had preferences for cooperative teacher interpersonal behavior.

According to Wu and Fazzaro (2013), Hudson found that science students mostly possessed a convergent style of thinking whereas, arts students mostly liked a divergent style of thinking (Fazarro, Pannkuk, Pavelock, Hubbard, (2009) quoted Lovell, 1980). Hudson’s work is significant because it offers the linkage between learning style theory and cognitive science.

Negahi, Ghashghaeizadeh and Hoshmandja (2012) quoted Homayuni et al. that subjects with assimilate and convergent learning styles would select mathematics and empirical science more than those subjects who utilized accommodate and divergent learning styles. But students with accommodate and divergent learning styles usually choose humanities more than those utilizing convergent and accommodate thinking styles.

Clark (2012) quoted Evans, Forney, Guido, Patton, & Renn, (2010) that, “Learning styles are categorized into four primary forms of meaning-making:
convergent, divergent, assimilation, and accommodative. Convergent learners utilize abstract conceptualization and active experimentation and are “inclined to be good problem solvers and decision makers” (p. 40) whereas, divergent learners are people-oriented and rely on concrete experience and reflective observation to generate solutions to problems utilizing diverse perspectives. Cognitive development occurs when learners begin to integrate additional learning dimensions into their preferred learning style.

Yeboah and Sarpong (2012) used Kolb learning style inventory to investigate higher grade achievers in computer programming. The study revealed that some learning styles are better than others in relation to grade achievement of the learner. A significant mean difference was found between learning styles of students and their actual grade achievement. Divergent learners were found better than convergent learners regarding grade achievement.

Cavas (2010) emphasized that:

It is commonly believed that learning styles are not really concerned with what’ learners learn, but rather ‘how’ they prefer to learn and it is also an Important factor for students’ academic achievement and attitudes. Teachers learning styles, teaching styles, and personality styles found to affect student’s achievement and attitudes toward any subject. (p.47)

Cavas investigated pre-service elementary teacher’s learning style as divergent, assimilator, convergent, and accommodator by using Kolb’s Learning Style Inventory. The results revealed that pre-service teacher’s dominant learning style was divergent and it was followed by accommodator learning style. Similarly except active experimentation, in all three groups, the learning style components did not significantly differ by gender.

According to Zhang and Sternberg (2011), the tendency towards convergent/divergent thinking commonly is derived from the performance on several tests instead of a single test. Moreover, the construct is also evaluated by tests
(usually open ended questions) that demand responses to make several answers (Riding and Cheema 1991)

Yildirim and Özkahraman (2011) described that the convergent learning style depends on abstract conceptualization and active experimentation. It enables an individual to be capable of decision making, problem solving, and application of ideas. In convergent learning style, knowledge is organized through hypothetical-deductive reasoning. Convergent individuals have control on emotions and select technical tasks instead of social issues. Cavas (2010) emphasized that convergers prefer to work themselves, solve problems and find practical solutions. Convergers like to study on technical projects instead of interpersonal relationships or social issues. Convergers can conduct laboratory experiments and can learn through computer-based learning methods easily.

Cavas (2010) found that Divergers depend upon concrete experience and reflective observation and prefer to view things from several viewpoints and therefore, diverging from a single experience to several possibilities. Divergers are so much open-minded that they desire to work with others. Usually, other people can easily inspire divergers and for them receiving constructive response is essential. The divergent learning style depends on concrete experiences and reflective observations. Divergers prefer adaptation by observation rather than action. In the designing process of their thoughts, their feelings and thoughts are at work. Divergers perform well when alternative ideas are required; they are imaginative and feeling oriented (Kolb, 1984).

Moore (2009) as quoted by Waine (2010) proposed that teachers must ask divergent questions frequently in the classroom because such questions can encourage and promote students individual thinking. Actually, divergent learning and thinking has been directly associated with creative thinking (White, 1990) because it requires thinking to solve a problem in divergent ways and encourages students to be more actively engaged in the learning process. Instead of requiring one single word of simple answer, a broader response is required for it.
Williamson (2011) studied the results of problem solving skills of undergraduate science and arts students. The tests were based upon preferred learning styles i.e. convergent/ divergent thinking, and creative problem solving skills. The study yields contrary findings to earlier results because differences were not identified in the problem solving skills of science and arts students. However, differences were identified in preferred learning styles but these were very much smaller than reported earlier. The findings revealed that modern graduates are possibly having more balanced educational profile as compared to their specialized prototypes.

According to Moore (2009), convergent learning is used when only one correct answer to a problem or question is required e.g. dichotomous yes or no, true or false. Convergent teaching is mostly teacher centered because knowledge is directly transmitted to the students (Sharma and Tomar, 2005).

Yang’s study (2007) revealed that university students were observed to use the convergent, divergent, and accommodating learning styles more frequently than assimilating learning styles in an online collaborative learning environment. According to Graf, Lin, Kinshuk (2007), Sensing and intuitive learners have characteristics similar to convergent and divergent.

According to Bowman, Evan and Turnbull (2005), convergent and divergent thinking styles are the most commonly investigated factor that has been used to explain individual differences. (Keefe and Magaro, 1980; Andreasen and Powers, 1975).

According to Shimodaira, Shimodaira and Kunifuji (2006) through convergent-style and divergent learning style, learners improve their language skills. In the convergent styles, learners try to concentrate the possible clues to find the right expressions and words, i.e. to answer by using various types of available resources. In the divergent activity, learners explore several resources not merely for having a better idea of the required word they are interested in but also to get other words, knowledge, and information related to the word.
Kwon, Park, and Park (2006) explored that how divergent teaching can be applied to Mathematics. Conventionally, in mathematics, students were taught that there is only one exact solution to a problem. It was discovered that through the use of open-ended problems and questions in mathematics, divergent thinking skills can be increased.

Sharma and Tomar (2005) have described that divergent learning is flexible and hence, classified as being student-centered, where the students are entirely indulged in their own learning. The students decide themselves the approach they will use and how to complete the assigned task.

According to Kolb as stated by Richmond and Cummings (2005) the greatest strength of convergent learner is the ability to solve problems efficiently, improved decision making and implement practical ideas to solve problems. Usually, convergers perform well on standard conventional intelligence tests because they can organize knowledge by hypothetical deductive reasoning and therefore, are able to converge to one given answer (Kolb, 1976; Torrealba, 1972). Divergent learners are best at tasks that demand “imaginative ability and awareness of meaning and value” (Kolb, 1984, p. 77). Divergent learners prefer the learning modes of concrete experiences and reflective observation.

Alamolhodaei (2002) compared students’ performance with Convergent / Divergent cognitive styles in mathematical pictorial problem solving. The findings of the study revealed that students with divergent cognitive styles showed higher performance as compared to convergent ones in pictorial problems. According to Alamolhodaei, the Convergence/Divergence style is extensively used dimension of cognitive style in education, it specifies an individual’s mode of perceiving, thinking, problem solving and visualizing. Zent (2001) described that divergent thinking includes taking a topic and breaking it down into its individual parts. Zent considered that convergent thinking is an important part of the outlining and organizing process.

Bahar and Hansell (2000) explored the relationship between the convergent / divergent cognitive styles and the field-dependence/field-independence dimension.
The focus of study was on the interactions between field-dependence and field-independence dimension, convergent and divergent styles and working memory capacity. A significant positive correlation was identified between the F.D cognitive style and low working memory capacity and the F.I cognitive style and high working memory capacity was identified. Moreover no significant relationship was found between the convergent/divergent style and field-dependence/field-independence, tendencies however indicated that divergent learners are more likely to prefer a F.I cognitive style and convergent learners tend to prefer a F.D cognitive style. In short, the study revealed that there is an overlap between a convergent thinking style, low working memory capacity, and field-dependence. Contrary to this, an interaction exists between divergent thinking, high working memory capacity, and field-independence.

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*Figure 2.5 Cognitive mapping by Bahar and Hansell (2000)*

According to Leng and Hoo (1997), there may be match and mismatch between both cognitive styles (convergent and divergent) with teaching strategies. Various teaching strategies practiced in science, mathematics and technology are characterized by structured, logical presentations and leading to a 'correct' answer. Therefore, these strategies encourage convergent thinking and discourage divergent thinking. Contrarily many teaching strategies in the arts encourage divergent thinking by providing learners an area of interest and asking them to make a project based on their area of study.

Hudson also explored the effects of matched and mismatched teaching strategies and learning styles. The results indicated that the convergent students learned best from the convergent teachers, while the divergent students learned best from the divergent teachers.
Zhang, Sternberg (2012) cited that Donoghue (1995) studied the relationship of the convergent/divergent construct with scales from the Myers-Briggs Type indicator. Significant relationship was found between the Convergent/divergent styles and the combination of intuition perceiving and sensing-judging types.

Donoghue (1994) analyzed the application of two diverse modes of thinking, convergent and divergent, in the problem solving process. A significant relationship found between learning style inventory (LSI), converger/diverger styles and Mayer Briggs Type Indicator (MBTI). Zhang (1985) stated that students in higher grades tended to score higher in divergent thinking. Strot (1985) studied the “attractiveness of students with convergent and divergent learning styles to teachers with convergent and divergent learning styles”. According to researchers there are two thinkers described in literature each of which exhibit unique type of cognitive excellence, i.e. convergers, and divergers. Convergers have been described as preferred over diversers by teachers.

According to Kolb (1981) the greatest strength of convergers lies in the practical application of ideas. Hudson’s research showed that convergers are
relatively unemotional. They prefer to deal with things instead of people. They are likely to select physical sciences. Divergers on the other hand have imaginative ability. They are interested in people and are imaginative and emotional.


Freeman, McComiskey, and Buttle (1968) identified that an important predictor of academic performance was the balance between convergence and divergence (Heywood, 2005).

2.3.4 Teaching Strategies for Field-Dependent and Convergent Learners

On the basis of literature review, The following educational conditions have been proposed by several researchers (Ennis, 1991; Wyss, 2002; Pithers, 2006; Sims & Sims, 2006; Nozari & Siamian, 2015) for Field-Dependent learners to maximize their learning. It includes:

i. provide social learning environment, provide clear directions and a maximum amount of guidance, offer “deliberate” structural support with cues e.g. advanced organizers, include orienting strategies before instruction such as present outlines or graphic organizers of content, provide relevant examples, provide extensive feedback, embed questions throughout learning.

Moreover the following instructional strategies may be used for Field-Dependent learners:

ii. Well-structured and well-organized material, combine Field-Independent teacher or student with Field-Dependent student, provide extensive positive and negative feedback, reduce stress, offer structural models for a given field, begin exercises with clear structure, numerous cues, provide consistent feedback, ask
students to recognize their own goals, provide scaffolding as the student progresses, providing several examples and non-examples.

For convergent learners, the symbolic learning environment and perceptual learning environment have been proposed by several researchers (Alamalhodae, 2001; Bautista, 2012; Biggs, 1887; Richmond & Cummings, 2000; Hajesfandiari, B., Mehrdad, A. G. & Karimi, 2014; Mosston, M. & Ashworth, 1990; Riding, R. J. & Sadler-Smith, 1997; Waine, 2010). In the symbolic learning environment, following course activities may include:

iii. Integration of lectures and traditional tests that focus on abstract concepts and theories e.g., quizzes, mid-terms, and end term examinations may be constructed using formats like multiple choice, true/false and essay type questions. In this learning environment, students prefer a hierarchical, lecture style that generates a didactic structure between the teacher and the student. Additionally, activities may also include evaluation of research in the content area (e.g., peer-reviewed educational science articles) and practical problems that require students to apply theoretical concepts to the details of the problems. Course activities may be evaluated providing clear, concrete, and objective criteria by the instructor.

For the convergers, the following course activities may include in the perceptual learning environment:

iv. Online reading materials/ editorials/ journals, lecture summaries, and asynchronous chat discussions. The content may be delivered through interactive lectures that may include reflective questions that require students for personal understanding/interpretation of course content (through asynchronous chat sessions). Additionally, for every main concept covered in the course, teachers may provide students with opportunities to recap (summarize) and reflect on those concepts and related activities. Evaluation activities may measure student’s performance by comparing their work to that of others in the field of science. In this learning environment, teachers may provide expert opinions yet de-emphasize making critical evaluations of students and course content.
Summary

The learning style of every individual is different from each other. Every individual learns and perceives information according to his/her unique learning style. There are only few number of styles which could get the attention of researchers; Field-Dependent (F.D) / Field-Independent (F.I) are one of the most well researched cognitive styles in the history. Witkin identified these two cognitive styles and defined these as “‘field- independence and field- dependence are two opposing cognitive behaviors that serve the same function – to allow the individual to select from and make sense of the potentially overwhelming tumult of experiences and information that bombard us daily”. The Field-Dependent individuals are different from Field-Independent individuals in restructuring skills, working memory and information processing, social orientation and concept attainment. Researchers reported several factors that could influence F.D/F.I such as gender, brought up and socioeconomic status of family. The studies showed that in science teaching and learning, the dimensión of field-independent and dependent must be considered particularly in such topics and domains that demand spatial thinking skills. The other teaching methods include inquiry method, project method, cooperative learning and problem solving method that could be used according to cognitive syle of students.

Similar to Field-Dependent /Field-Independent cognitive styles of learning, the convergent/divergent styles of cognitive learning have significance in educational settings. Science learning demands good problem solving skills and abstract thinking skills. According to Western university of health sciences, the understanding of one’s own learning style can be helpful to recognize one’s own strengths as well as limitations as a learner. Divergers are best at using concrete experience and reflective observation and enjoy small group discussions and brainstorming. They like to collect information and have wide interests. They have tendency to see the events instead of participating them. On the other hand convergers are best at using abstract conceptualization and active experimentation. They have the skill to find practical applications for concepts, ideas, and theories. They enjoy circumstances which require a distinct or best answer to a problem.
Several researchers have been conducted to examine the relevance of convergent/divergent cognitive styles of learning in science education. Individuals with divergent learning styles show a better scholastic performance compared with those participants with convergent learning styles. Moreover the performance of males was different from females.

PART-IV

2.4 RELATED RESEARCHES

This section contains the analysis of different studies regarding cognition, attitude, and achievements. Moreover the studies regarding the mutual relationships of these variables have also been analyzed.


2.4.1 Cognitive Learning styles

Muhammad, Daniel, and Abdurrauf (2015) found most of the students as Field-Dependent. The researcher justified this finding and inferred that this Field-Dependence may be due to the concrete level of cognitive thinking.

Field-Independent individuals are inclined towards careers (engineering, doctor, biologist, etc.) (Witkin et al., 1977).

Çakıroğlu’s findings (2014) found that the prominent learning style of Turkish students were convergers. Kolb also described that most of the science students have convergent learning style. It may be due to the reason that science students usually prefer learning through practical applications, including working with
technical works or problems, solving problems, trying to make correct decisions, and preferring to work with technical work or problems.

2.4.2 Cognition and Attitude towards Science

Nozari and Siamian, 2015 found that Field–Independent undergraduate students had greater attitudes than Field-Dependents students.

Oneykuru (2015) found that the performance of Field-Independent students was significantly better than Field-Dependent students because Field-Independent students are better problem solvers than the Field-Dependent students and problem-solving ability is a crucial factor in teaching and learning of science.

Feist (2012), predicted that the cognitive style and need for cognition can predict student’s interest in science. Feist argued that, “if young talented minds are to incline to a life of science, they first must have a positive attitude toward and develop an interest in science” (p.771)

Peker (2009), found significant differences between divergent learners and convergent learners’ attitude in mathematics. It was revealed that this difference was due to convergent learners.

The study of science from psychological perspective (psychology of science) is still in its initial stages (Feist, 2006; Feist & Gorman, 1998; Park, Lubinski and Benbow, 2008; Subotnik & Steiner, 1994b). Simonton (2009) and Feist (2006, 2012) stated that “Psychology, more than other studies of science, has the theoretical and methodological tools for answering questions of how attitudes toward and interest in science develops (p.771)”

Comek, Bayram (2010) explored the effect of web based homework on academic achievement and science teaching attitude for students with various learning styles and made a comparison with the use of traditional homework. Research findings showed that academic achievement of the students differed with respect to their learning styles. Conversely no significant difference was found in relation to attitude towards science teaching for learners with different learning styles.
Holland (1992) described that there are “two significant psychological factors” behind interest in science i.e. cognitive styles of learning and attitude towards science among undergraduate science students.

### 2.4.3 Cognitive Styles and Science Academic Achievement

Dudek, Strobel, Runco (1993) and Roue (2014) Klausmeier and Wiersma’s (1964b) found that generally, a female obtained higher scores than a male divergent in thinking tests.

Dudek et al. (1993) and Artola (2013) found that female scored more in divergent tests as compared to male.

Cellar, Durr, and Hassell (1989) as quoted by Schuler, Farr, and Smith (2013) that females provided higher level of accuracy and so founded higher Field-Independent.

Mutlu and Tamiz (2013), found that some researchers have compared the academic achievement of Field-Dependent and Field-Independent students in various science courses. Generally, the findings of these studies revealed that in some courses containing mathematics and science the Field-Independent students were more successful than Field-Dependent students (Horzum and Alper, 2006; Karaçam and Ateş, 2010).

Çakıroğlu, Capa-Aydin and Hoy, (2012) found that divergers had higher average scores and learned better through feeling and watching. It may be due to the reason that divergers watch and observe.

Kenth (2011) has cited various studies regarding cognitive styles and academic achievement and found that Field-Independent cognitive style achieved significantly higher mean scores in Math, English, Social Studies, General Science and Drawing than Field-Dependent class fellows (Vera and Swain, 1991).

Karademir and Tezel (2010), as the researchers found Turkish university students having accommodating and diverging cognitive learning style.
Yim’s (2009) conducted study on the cognitive learning styles of science students of India. The researcher found that female scored much more than male on GEFT. The female students scored nine percent higher than the male students in science academic stream. This indicated that female students in the science academic stream have the capacity to do analysis than the male students. This might be due to the social-economic developments of the countries or the socio economic status of families. In this era, females are more concerned about their education in order to get better jobs. They travel and reach institutions to get education. It shows that females are independent and they want to be successful in society. As Yim said “the cost to their family to send them to a boarding is high, and therefore, they have pressure to do well” (p.93). Yim (2009)’s study revealed no significant difference between academic achievement of male and female Field-Independents.

Bassey, Umoren, and Udida (2007) investigated the effect of cognitive styles and attitude on the student’s academic performance in chemistry in Akwalbom State. The results showed a significant difference in academic performance of students in chemistry. Moreover a significant positive relationship was found between student’s performance in chemistry and attitude of students towards chemistry.

Okwo and Otubah (2007), Tinajero, Lemos, Araújo, Ferraces and Páramo (2012) also found that Field-Dependent students scored lower results than Field-Independent class fellows.

Okwo and Otubah (2007) and Adeyemi (1992) found that Field-Independent students performed significantly better than Field-Dependent students in physics and biology respectively.

Manochehr, (2006) quoted Daniel’s (1999) that divergers preferred reflective observation (watching), and achieved significantly higher scores. It is due to the characteristics of divergers that they “learn when allowed to observe and gather a wide range of information”.

Danili and Reid (2006) found that in assessments that require students to have linguistic skills in order to interpret and elaborate a given text or to explain
phenomena, ideas and concepts, or to describe differences, the convergent/divergent style is an important factor for students to perform well.

The same trend has been found in different educational levels and has been verified with different samples of several cultures (Cano, 2006; Danili & Reid, 2004, 2006; Garton, Ball and Dyer, 2002; Tinajero & Páramo, 1997, 1998; Tsaparlis, 2005; Zhang & Sternberg, 2005). It may be due to the reason that Field-Dependent/Field-Independent characteristic correlated with student’s performance in all formats of assessment (although not always significantly).

Danili and Reid (2006) described that being Field-Independent appears to be a very significant factor which effects whether students perform well in almost all types of assessments, irrespective of the content of the questions. Moreover, as problem solving is significant ability for teaching and learning science. Therefore, Field-Independent students are better in solving problems as compared to Field-Dependent students.

Vodopivec, Vujaklija, Hrabak, Lukiae, Marusiae and Matko (2002) found that the students obtaining high scores in admission tests also exhibited more positive attitude towards science. Hansen (1995) found that cognitive style influenced the choice of a major subject and found that students obtained higher scores in such fields that were well-matched with their cognitive style.

O’Brien and Wilkinson (1992) revealed that both Field-Independent male and female performed better than Field-Dependent in all subjects.

O’Brien and Wilkinson (1992) revealed that both Field-Independent boys and girls performed better than Field-Dependent ones on all subjects. It was found that the Field-Independent students had a higher mean academic achievement in science than the Field-Dependent students. Moreover, the difference in mean values of academic achievement was significant.
Hansen (1995), found that in postsecondary technology programme Field-Independent subjects achieved significantly higher mean grades than their Field-Dependent counterparts.

2.4.4 Personality, Interest and Attitudes towards Science

Baker (2006) found that male and female students scoring higher grades had many features of the scientific personality and good scores in mathematics but possessed negative attitudes toward science. Whereas, male and female students scoring lower grades had few characteristics of scientific personality, poor mathematical and spatial abilities but more positive attitude towards science.

2.4.5 Gender and Cognitive Style


Roue (2014) found that there is no difference between girls and boys on the measures of divergent thinking. Roue (2014) mentioned that divergent thinking is an important characteristic in science and engineering and direct measure of creativity. There are mixed results of Studies on divergent thinking and gender.

Bhatti (2013), also found that most of the male science students were convergent whereas, majority of the female were found as divergent. Zhang (2013) described that in sports world a reversed gap and a reduced gap have been found.

Mutlu and Temiz (2013) found that females were more Field-Independent in Physics, Bio, and Mathematics than male. This is because as the inclination of field independence increases, so does the interest in abstract and analytic fields.

Li (2011) and Bellard (2001), Bieri (1960), Loader, Edward and Henschen (1982), Waber (1977), Torres (1990), Healy, Harkinson and Ray (2010) showed that male are more Field-Independent.
Similar to Yim (2009), Linn and Hyde (1989) stated that gender differences are not general but specific to cultural and situational frameworks. It is significant to note that the accuracy of measurements of creativity and the divergent thinking process, even after years of research, is still open to differing opinions.

Kuhn and Holling (2009) found females to be more divergent on verbal and figural tasks and also found that older students were more divergent.

Craker (2006), found that males have more confidence/attitude towards science (subject) than females. It may be due to the reason that females considered science as a male domain more than males did.

Davis (2006) has cited many researches regarding gender and cognitive learning styles and found that:

Spelke (2005) found that research provides evidence regarding development of mathematical and scientific reasoning from a set of biologically based cognitive capacities that males and females share. These capacities lead men and women to develop equal talent for mathematics and science.

Reese, Lee, Cohen, & Puckett (2001) studied 400 adults of 17 years and above and found insignificant results in establishing an association between divergent thinking and gender. Thomas and Berk (1981) recommended that gender differences were predictive of creativity. Chen et al., (2002) found that boys were more divergent.

Severiens and Ten Dam (1997) as quoted by Zhang and Sternberg (2001) described that the mixed and even contradictory findings of the relationships between styles and gender is due to various contexts (e.g., different countries and different subject matters) in which the empirical studies were conducted. Additionally, the mixed results could be due to the varying age levels of the students who responded to the items in the inventory.
Miller (1997) and Torres and Caño and Marquez (1995) also found females as Field-Independent. Although no study from science domain was found to support or disapprove this finding.

Many critics propose that these tests have nothing in place to account for the many factors that cause variation within a person’s creative production, nor for the variation within and between tests of creativity. They also question whether domain-specific questions impact the measurement of creativity (Brown, 1990).

Hansson, Rydén and Johnson (1986) found females more Field-Dependent than males. Witkin and Goodenough (1980) also found that “liberated” females tended to be more Field-Independent than those who preferred the traditional female roles.

Pargman, (1977) found female athletes more field-Independent than male athletes. Vernon (1972) argued that both genetic and socialization factors are involved in the development of F.D/ F.I.

Researchers (Cano & Garton, 1994; Garger & Guild, 1984; Hudson, 1997; Torres & Cano, 1994; Witkin, 1976, Witkin et al., 1977) have revealed that as compared to females, males were found to be less Field-Dependent. Whereas, other studies (Garton, Spain, Lamberson, & Spiers, 1999; Raven et al., 1993; Whittington & Ravena, 1995) showed mixed result among male and female students of agriculture. According to Crosson (1984), as age increases, both genders generally become more field-dependent. (p.91)

Klausmeier and Wiersma (1964a) revealed that gender has foremost impact on divergent thinking tests and found that girls had higher mean score on divergent thinking as compared to mean score of boys.

These researches show that there are mixed results regarding age and cognitive learning styles with respect to gender.
2.4.6 Cognitive Style, Online Learning and Assessment

Yecan (2005) explored the learning strategies of students with various cognitive styles in hypermedia environment and found some differences among different cognitive style groups of students in relation to their preferred learning strategies.

Graff (2003a, b) found no relationship of attitudes towards computer-assisted learning with performance on each of the online methods employed, however, some relationships were found between cognitive styles, online learning and assessment.

Kim & Allen, (2002) emphasized that the development of the World Wide Web (www) has considerably transformed the mode of presentation and retrieval of information in information systems. Ford (2000) stated that “virtual environments allow greater flexibility of navigation than do their physical counterparts (p.543).” Therefore, varieties of ways are now available to get the same piece of information and users can make autonomous decisions for searching. Lucas-Stannard (2003) quoted Saracevic & Kantor (1991) that “research on how users adapt to this new environment is important in building more intelligent information retrieval systems with an understanding of human-computer interaction principles. One of the characteristics that effect user interaction with systems is their cognitive style (p.8)”. Diaz D.P (2000) revealed that online students demonstrate significantly different learning styles when compared to the students of traditional classroom.

2.4.7 Cognitive Styles, Achievement Scores and Attitudes toward Computers

According to Kozhevnikov (2007) researchers revealed that cognitive styles can be helpful in predicting the academic achievement beyond general abilities (Zhang & Sternberg, 2001). Altun and Akan (2006) investigated relationship of cognitive styles, achievement scores, and attitudes toward computers among university students by using standardized GEFT to evaluate field dependency. The findings indicated that sample’s attitudes toward computers were not related with
field dependency. Therefore, it was found that attitude towards computers function independently from cognitive styles.

2.4.8 Students’ Cognitive Styles and Attitudes towards Using Blogs.

In e-learning, learners’ characteristics become an important issue nowadays. Within this area, one of the key factors that can influence learning processes and learners’ performance is cognitive style i.e field dependency. Shahsavar & Tan. (2010) evaluated the effect of bloggers’ cognitive style on their attitudes toward blogs. In order to classify the students as field-dependent and field-independent, Witkin’s GEFT was administered. A blog attitude questionnaire was used to assess attitudes of students towards blogs. Although study found no significant relationship between students’ field dependency and their attitudes towards blog, most bloggers demonstrated positive attitudes towards using blogs in a learning environment.

Umoren and Etokebe (2008) explored cognitive styles, attitude towards computer and academic achievement of undergraduate students. It was found that the performance of F.I students was better than F.D students in introduction to computer. Student’s towards computer were positive and associated with their performance. Students of science faculties (medicine and science) performed better than students from other faculties. The study recommended that teaching and learning must take cognizance of cognitive styles as it is instrumental to the realization of potentials.

2.4.9 F.D/F.I and Academic Achievement

Ku and Soulier (2009) found that studies regarding reading comprehension and second language learning infrequently supported the significant relationship between F.D/F.I styles and student’s academic achievement (Liu & Reed, 1995; Zhou, 1999). However, there are various studies which investigated the contributions of F.D/F.I styles the student’s academic achievement in specific subject matters.

Altun and Cakan (2006) stated that there was no significant relationship between F.D/F.I cognitive styles and academic achievement (r= .14, p=.15).
Abdollahpour, Kadivar, and Abdollahi (2005) found significant difference between F.D and F.I groups in mathematics achievement. It was revealed that the performance of Field-Independent was better in mathematics.

In some studies there are traces of exploration of relationship between F.D/F.I styles and general academic achievements at elementary level (Saracho, 2002) some at secondary level (Kirk, 2000) and some at higher education level (e.g. Savage, 1983). Savage (1983) found that “young children’s academic achievement rose as a function of their cognitive styles.” (p.234)

Kirk (2000) explored the relationship of cognitive style to the achievement in chemistry and found strong correlation of field independence with academic achievement in chemistry.

Literature revealed a close association between F.D/F.I styles and student’s learning achievement in subject matters, such as information management, biology, and chemistry (Kirk, 2000; Murphy & Casey, 1997).

2.4.10 Guilford’s Divergent-Convergent Thinking and Academic Achievement

Peker (2009), found significant differences between divergent learners and convergent learners’ attitude in mathematics. It was revealed that this difference was for convergent learners.

Demirbas & Demirkin (2007) found that a divergent thinker flexibly deals with problems; whereas, convergent thinker deals with problems in a mechanical way. The research revealed a relationship between academic achievement and convergent/divergent thinking pattern. According to Zhang & Sternberg (2005) latest literature has more likely considered divergent-convergent thinking styles as intellectual styles.

Literature revealed that Guilford’s divergent-convergent thinking is mostly associated with learning performance of an individual. The divergent thinking style often displays positive effect on academic achievements at various educational levels and various subject matters.
2.4.11 Attitudes and Academic Achievement

Academic achievement and how it is obtained and maintained is critical to education, along with identifying the characteristics of students who are achieving in the classroom. Khamari and Guru (2013) stated that attitude towards education, teacher, and family and society influence academic achievement of the students at secondary level.

Kinniard (2010) emphasized that researches continued to determine relationships and correlations between academic achievement and the characteristics of the learners that are successful in the classroom. Sua (2007) stated that “Attitude and achievement have frequently being quoted as significant and desirable educational outcomes” (p.17). Sua argued that, “it is usually true that attitudes of students towards learning of a subject have a significant impact on the outcome of their learning processes”.

Lewis (1981) as quoted by Sua (2007) proposed important perspective into the “nature of attitudes”. Sua perceived that attitudes are “mental sets, which are a cluster of preconditions that determine the evaluation of a task, a situation, an institution, or an object before one actually faces it” (p.17).

From the perspective of Baker (1988) as quoted by Sua (2007), “attitudes as inferred, conceptual inventions hopefully aiding the description and explanation of behavior. Seen in this context, attitudes are learned predispositions, not inherited or genetically endowed, and are likely to be relatively stable over time” (p.17).

2.4.12 Attitude towards Science and Achievement

Narmadha and Chamundeshwari (2013) found a positive correlation between attitude towards learning Science and academic achievement in Science. However, most of the research regarding attitude towards science and its relationship to science achievement showed low positive correlations.
Ali and Awan (2013) explored the relationship between attitude towards science and achievement in science subjects such as Chemistry, Physics, Biology, and Mathematics at secondary school level. The results showed the significant positive relationship between attitude towards science and student’s achievement in science. Ali and Awan cited that substantial amount of research is available on factors affecting achievement of students in science (Bennet, 2003), importance of various attitudes towards science (Zembylas, & Papanastasiou, 2002) and science achievements.

Narmadha and Chamundeswari (2013) found that females were significantly better regarding attitude towards learning of Science as compared to the male in all categories of schools. In matriculation and central board schools the female students are better than male in their academic achievement in Science whereas, in state board schools there is no significant difference in their gender.

Ali and Awan cited that several factors influence attitude towards science such as:


Ali (2012) has described that numerous researches have been conducted in various countries which cover the domains of attitude towards science and science achievement (Eccles, 2007; Zembylas & Papanastasiou, 2004; Ferreira, 2003; Dhindsa & Chung, 2003; Mattern & Schau, 2002; Freedman, 1997; House, 1993; Simpson & Oliver, 1990)”(p.3).

Many researchers (Cakmakci, Sevindik, Pektas, Uysal, Kole and Kavak, 2012; Bennett and Hogarth 2009; Osborne et al. 2003) found that in England, student’s positive attitudes towards science decreases significantly among the age group 11-15 years for students. It was also found that for girls, science is less
attractive than boys. The deficiency of student’s curiosity in the curricula of science, motivation, and interest not only influence student’s educational path or career choice but also the quality and quantity of learning outcomes (Hidi et. al. 2004 as cited by Dunst, Raab, 2004; Osborne 2007). But still “having positive attitudes towards science and scientists is particularly important for students to make well-informed choices and decisions about their future careers (Finson 2002; Rocard et al. 2007)”. Conversely, negative attitudes towards science can cause “a serious threat to economic prosperity and diversity” (Osborne et al. 2003; Sjøberg 2000, Gago et al.2004).

Najafi, et. al (2012) also showed that although there were not large differences existed between male and female about attitude towards science and technology, However, females generally have less average in attitude than males.

The findings of Najafi, Ebrahimitabass, Dehghani and Rezaei (2012), Jenkins (2006) , Simpson and Oliver (1990) also reported that males demonstrated significantly more positive attitude towards science as compared to females.

According to Kirrikkaya (2011) numerous studies have shown that male have better attitudes towards science than females, and that boys are more inclined to continue studying science (Craker, 2006; Parkinson at al., 1998; Weinburgh, 2000). Some of the researchers stated that, students’ achievements in science affected their attitudes by investigating relationships between students’ attitudes towards science and their achievement in science (Oliver and Simpson, 1988; Simpson and Oliver, 1990). According to researches, the nature of science education significantly affects learner’s attitudes towards science and attitudes towards science courses have the feature of being one of the most important variables in determining students’ achievements. Researchers have found the positive correlation between science attitudes with science achievement and involvement in advanced courses of science (Simpson & Oliver, 1990; Lee & Burkam, 1996; Papanastasiou and Papanastasiou, 2004).

Hussain, khan, Latif, Amin and Sibtain, (2011) that female science students exhibited significantly better results than male science students. Akcay, Yager,
Iskander and Turgut (2010) as these researchers also found no significant difference between attitudes towards science of male and female science students.

According to Selcuk, Zayas & Hazan (2010), academic success or failure is related to many casual factors which effect education. These factors include students (personal) factors, teachers (academic) factors and parents (family) (Diaz, A.L 2003). When literature on physics education is reviewed, it is seen that the most frequently analyzed personal variables relating to achievement are gender, attitude, and motivation. The correlation between students’ achievement in physics and gender has been a popular research subject in recent years. The findings of several studies show that there is a correlation between students’ achievement in physics, gender and that boys are more successful than their female at learning physics (Kost, Pollock, & Finkelstein, 2009, 2010; Pollock, Finkelstein, & Kost, 2007). The studies examining the relationship between achievement in physics and gender present findings demonstrating that factors such as student’s age (Beaton et al., 1996; Kahle & Meece, 1994), attitude and interest towards physics (Kahle, Parker, Rennie, & Riley, 1993; Baker & Leary, 1995; Farenga & Joyce, 1997; Jones, Hove, & Rua, 2000) and social and linguistic behavior (Stadler, Duit, & Benke, 2000) are pretty effective moderator variables regarding this relationship.

According to Akcay, Yager, Iskander & Turgut (2010) attitudes towards science, scientists and learning science have constantly been a concern for science educators. Attitude has been used very broadly in the discussing issues in science education and is often used in several contexts.

Eccles (2007) (as quoted by Orbay, Gokdere, Tereci and Aydin, 2010), revealed a strong relationship between student’s attitude towards science and science achievement in middle school. Moreover it was also found that positive attitudes towards science yield higher achievements.

Balım, Sucuoğlu & Aydin (2009) cited many researches which showed that students with positive attitude towards science perform better in terms of academic success. Selçuk, (2010) found that there is correlation study of physics achievement, learning strategy, attitude and gender in an introductory physics course.
The recent studies in research journals have indicated positive correlations between attitudes toward science and achievement in science courses. Moreover, attitude and certain characteristics of the classroom environments such as innovative learning activities, using various teaching strategies, personal support, and student-centered instructional designs have all been reported in the recent research journals (Osborne, Simon & Collins 2003; Warner, 2008).

Ferreira (2003) as cited by Desy, Peterson, Brockman (2009) found a significant positive relationship between student’s attitude towards science and achievement in science. It was also found that student’s positive attitude towards science produced the higher achievement in science.

Evans (2007) found significant correlations between student attitudes towards statistics and achievement in statistics both at the beginning and end of the course.

Defiana (1995) (as cited by Adesoji, 2008) found that the attitudes of high school students toward and awareness about the environment can be improved using integrated science environment activities. Serin and Mohammadzadeh (2008) revealed that students’ gender, socio-economic status of their families, the perceptions of their parents' attitudes and their perceptions of science achievements have a significant effect on student’s attitudes towards science. It was found that a meaningful relationship (r=.238, p<.001) existed between the student’s attitude towards science and achievement in science at primary school level.

Jordan, Rousch, and Howe (2006) investigated undergraduate student’s attitude towards science and science careers. It was found that the experience of probing students’ understanding and attitudes to be invaluable to the modification of practice. It was proposed that formative assessment, reflection, and human perspective in coursework and research projects would deepen the interest and understanding of science.

Craker (2006) emphasized that the study of attitudes is interesting as science careers are continuously and rapidly growing, furthermore, it is worth examining
further how and when students develop their attitude towards science and what can be done for the improvement of attitude.

Research studies indicate more positive attitudes are necessary for female students to achieve high scores (Jarvis & Pell, 2005).

Schau (2002) (as cited by Papadimitriou, 2004) found no significant influence of attitude and achievement in science among females, while the findings were dissimilar in case of males.

Astrom (2001) examined the relationship between student achievement in science and student’s positive attitude towards science (PATS) in four countries. Numerous researches (Simpson, 1978; Wilson, 1983; Soyibo, 1985; Slee 1964) reported high correlation of positive attitudes to science with the science achievement.

Papanastasiou (2002) revealed that number of researchers have verified a significant correlation between attitude and achievement. Kopsovich (2001) quoted Kolb (1984) that, “a major function of education is to shape students attitudes and orientations towards learning to instill positive attitude towards learning and thirst for knowledge and to develop effective learning skills” (p.11).

Parker and Gerber (2000) stated that for the achievement in science, attitude towards science are very significant because attitudes and achievement lead the students to the selection of future careers. Schreiber (2000) found that many researches have revealed that positive attitudes are helpful for student’s good performance.

Most of the research regarding attitude towards science and its relationship to science achievement showed low positive correlations (Germann, 1998; Keeves & Morganstern, 1992; Schibeci & Riley, 1986). Similarly, Neathery (1997) found no significant difference between the attitude towards science and gender.

Freedman (1997) explored the relationship of student’s attitude towards science and achievement in science. Twenty physical science classes were considered
for data collection. A positive correlation was revealed between achievement of students and their attitude towards science. However, Shashaani and Khalili (2001) surveyed the students' attitude in relation to parental encouragement, gender, and experience.

Benhow and Minor (1986) found that mathematically talented male and female students, incline to have favorable attitude towards science and to participate in the sciences at a level much higher than average. There were no overall gender differences in course-taking or course-grades in the sciences. Indications of gender differences favoring males, however, were found in participation in high school physics, the taking of and performance on high school and college level science achievement tests, and intention to major in the more quantitatively oriented fields of physics and engineering.

Schibeci (1984) that males demonstrated more attitude towards Physics and females demonstrated more positive attitude toward Biology. In the engineering science strata, no significant difference was found. Jarvis & Pell (2005) found that students who have positive attitudes showed more attention to classroom instruction and participated in science activities. Neathery (1997) found that with multiple correlation that attitude towards science correlated with science achievement. Gardner (1975) had distinguished these two broad categories. The first one is attitude towards science and the second one is scientific attitude.

2.4.13 Attitude towards Science Subjects

Arslan, Çanlı, and Sabo (2012) explored the effect of attitude, gender, and achievement on mathematic education among 6th, 7th, and 8th grade students. A significant difference had been found in terms of grade level and gender regarding student’s attitude toward mathematics and scores achievement in mathematics. The female students achieved more scores and showed positive attitude towards mathematics as compared to male students. Similarly the attitude of female students towards mathematics was more positive than male students.
Nasr and Soltani (2011) found no significant difference between female and male student’s attitude towards biology. Sua (2007) found the positive inter correlations between achievement and attitudes orientations towards learning science and mathematics. Sorge and Schau (2002) showed that there was an impact of engineering student’s attitude towards statistics and prior academic achievement on the ‘introductory statistics’ courses achievement. Shih and Gamon (2001) explored the relationships between student achievement and certain factors such as selected demographics, learning styles, attitude and motivation. It was found that only motivation was the significant factor to explain student’s achievement.

Atnafu (2010) examined the association of student’s attitude towards algebra and components of attitude towards algebra with the algebra achievements. The study revealed a weak relationship between algebra achievement and attitudes towards algebra. Kouassi (1999a,b) explored interest and achievement of male and female in mathematics. It was found that high-achieving female students possessed more positive attitudes towards problem solving and usefulness of mathematics as compared to low-achieving students.

These reviewed studies revealed the relationship between attitude and achievement, attitude and instructional methods. It has been found that attitude scores can be used to predict academic achievement.
CHAPTER 3

METHODS AND PROCEDURES

The present research study was conducted to compare the cognitive learning styles and science related attitude of science students at undergraduate level. Initially cognitive learning styles of undergraduate science students were found out then their science related attitude were measured. In order to generalize the findings of the sample to population, the results were quantified. Therefore, the quantitative approach was used for this research study.

In this chapter, all the details of methodology which was employed throughout the research have been described. The research design, population, sampling technique, sampling size, instruments of the study, pilot testing of the instruments, reliability and validity of the instruments and data collection procedures have been discussed.

3.1 Research Design

This is a quantitative research. The study was descriptive in nature. Survey was used for data collection. In this research, cognitive learning styles were considered as an independent variable, whereas, science related attitude and academic achievement was considered as dependent variable. The study was carried out to compare the cognitive learning styles and science related attitude of science students at undergraduate level in the public and private sector universities of Islamabad. The extraneous variables were gender, age, residential location, marks obtained in Higher secondary level, subject studied during higher secondary studies, people who guided the students to select the BS program, educational qualification of father and mother, father’s profession and mother’s profession (if working).

The study involves collecting data in order to test hypotheses concerning the
status of the subject of study. As in the survey research, data has been collected through questionnaire/s and standardized testes for the identification of cognitive learning styles. The variables such as gender, semester, demographics were also considered. The comparison of the cognitive learning styles of undergraduate science students, science related attitude and academic achievement of undergraduate science students were examined. Moreover the correlation of cognitive styles with science related attitude and academic achievement was found. The correlation of academic results with attitude was also taken into consideration in this study.

3.2 Conceptual Framework

Cognitive learning styles and attitude of undergraduate science students were the focus of the study. The literature revealed that academic subjects such as mathematics, science have traditionally been taught in a manner that only benefits abstract learners. The research of Kolb and others concluded that less than one fourth of our students are abstract learners. According to Center for Occupational Research and Development (CORD), Inc., USA (1999), the traditional methods of class room teaching does not touch the way learners process the information and enhance their motivation for learning. According to Guilford, among process of intellect, two processes i.e convergent thought production and divergent thought production are contributing in the development of scientific attitude. In this study the cognitive learning styles and science related attitude of science students were identified and compared. The study also explored the relationship between cognitive learning styles and science related attitude of science students. Furthermore, the relationship of attitude of students with their academic achievements was also identified in this study.
3.3 Population

According to Bless, Smith, and Kagee (2006), “a population, sometimes referred to as a “target population” is the set of elements that the research focuses upon and to which the results obtained by testing the sample should be generalized. It is absolutely essential to describe accurately the target population. This can effectively be done by defining the properties to be analyzed, using an operational definition. Once this is done it should be possible to compile a list of all elements of this population or, at least, to determine whether or not an element belongs to the population under investigation. In this sense the population will be well defined” (p.99).

Keeping in view the above definition, the population for the study consisted of all undergraduate students studying science in first (1st) and eighth (8th) semesters of undergraduate science programs of public and private sector universities/DAI’s of Islamabad.

As the population of the study is undergraduate science students enrolled in different science programmes offered by Higher Education Commission recognized universities/degree awarding institutes of Islamabad. Therefore, there is need to
briefly describe the function of Higher Education Commission (HEC) for the promotion of higher education sector.

Higher Education Commission (HEC) facilitates the development of higher educational system in the country with main purpose of upgrading the universities and colleges in the country to be focal point of the high learning of education, research, and development. The HEC is an independent, autonomous, and constitutionally established institution of primary funding, overseeing, regulating, and accrediting the higher education in Pakistan.

A committee of experts comprising of conveners from the National Curriculum Revision of HEC in Basic, Applied Social Sciences and Engineering disciplines met in April 2007 and developed a unified template to standardize degree programs in the country to bring the national curriculum at par with international standards, and to fulfill the needs of the local industries. It also aimed to give a basic, broad based knowledge to the students to ensure the quality of education. The new BS degree shall be of 4 years duration, and will require the completion of 130-136 credit hours. For those social sciences and basic sciences degrees, 63.50% of the curriculum will consist of discipline specific courses, and 36.50% will consist of compulsory courses and general courses offered through other departments. Over the several years, the HEC plays an important and leading role towards building a knowledge based economy in Pakistan by giving out hundreds of doctoral scholarships for education abroad every year.

As per Higher Education Commission of Pakistan (2012) (Annexure-F), there were eleven (11) public sector universities and three (3) private sector universities in Islamabad. The list of universities is as follows:

**Sr.No. Public Sector Universities**

1. Air University, Islamabad (AU)
2. Allama Iqbal Open University, Islamabad (AIOU)
3. Bahria University, Islamabad (BUI)
Initially, thirty two (32) programs were planned to be considered for data collection. But it was revealed by survey that most of the programs were not common in all universities/DAIs. Moreover, there were several other constraints/limitations such as permission to collect data, willingness and availability to participate, and cooperation of the management of universities, financial and time constraints of the researcher etc.

As the present study was a comparative study, therefore, logic was developed to consider only those programs which were common in at least three universities so
that comparison could be made easily and logically.

Pakistan Institute of Engineering & Applied Sciences, Islamabad (PIEAS) was not included in the study because this Degree Awarding Institute (DAI) is situated far away from the periphery of the city therefore, it was inaccessible for the researcher. Foundation University (FU) and QAU were not included for the study as BS programs in sciences were not offered at both universities therefore, these were also not included in the sample. AIOU was also not included in the study as it offers BS programs in distance learning mode, secondly the classes are arranged on weekends. Moreover there was difficulty in obtaining the semester results. Third reason was that the results were in percentage rather than Grade Point Average. Therefore, AIOU was not included in the sample. Air University (AU) and Bahria University Islamabad (BUI) were also excluded due to security reasons, circumstances of capital territory and time constraint.

Moreover, due to time constraints, objectives, hypotheses and depth of research, out of sixteen (16) variables, only eight (08) variables such as name, semester, session, Institution name, gender, demographics, Roll No/Reg.No., and programmes were used in this research.

3.5 Delimitation

Because of the above mentioned limitations, the study was delimited to six (06) public sector universities and two (02) private sector universities. The study was also delimited to six (06) BS science programmes offered by the eight universities/DAIs of Islamabad, Pakistan. The population of the study was homogeneous in nature and comprised up of 4807 undergraduate science students studying in the 1st and 8th semesters of selected programmes of nine universities/DAI’s. According to Yount (2006), “homogeneity in a population means that the members of the population are similar on the characteristic under study” (pp-7-3).

As a result, for the present study, the following BS programs were considered.
1. BS Physics (BS PHY)
2. BS Math (BS MATH)
3. BS Bio Sciences (BS Bio Sci./BS Bio Technology/Bio Informatics/
   Environmental Sciences)
4. BS Computer Sciences (BS CS)
5. BS Electrical Engineering (BS EE/ BS Telecom Engineering TE)
6. BS Computer Engineering (BS CE)

3.6 Sample and Sampling Technique

3.6.1 Sample. According to Gay and Airasian (2006), “sampling is the process of
selecting a number of individuals for a study in such a way that the individuals
represent the larger group from which they were selected. The individuals comprise
a sample and larger group referred to as a population”.

The quality of a piece of research depends not only on the appropriateness of
methodology and instrumentation but also by the suitability of the sampling strategy
that has been adopted. Questions of sampling arise directly out of the issue of
defining the “population” on which the research will focus.

Gay and Airasian (2006) suggested that for selecting sample of a population,
10% of large populations, and 20% of small populations as minimums” (p.114-115).
It is left to the students to weigh the factors of accuracy, cost, time, accessibility,
homogeneity of the accessible population, type of sampling and kind of study, and
determine the best sample size for his/her study.

Certain aspects and factors hinder accessibility of sample and frequently
prevent researchers from gaining information from the whole population. Therefore,
a reasonable sample must be chosen in such a way that the knowledge gained is
representative of the total population. This smaller subset or group is called sample.
For the present study, the sample consists of undergraduate science students of 1st
and 8th semesters studying in the Eight (08) universities/ DAIs of Islamabad.
3.6.2 Sampling Technique and Sample Selection. For the present study stratified random sampling was used. According to Cottrell, McKenzie (2010), “a stratified random sample might be used if it is believed that because of the small numbers of a certain group in the study population, representatives from that group may not be selected using a simple random sample” (p.130).

The population was divided into following three science strata, and respondents were randomly selected from each stratum.

i. Basic Sciences (Physics, Mathematics, Biosciences/Bioinformatics, / Biotechnology/Environment)

ii. Computer Sciences (Computer Science)

iii. Engineering Sciences (Electrical Engineering/ Telecom Engineering, Computer Engineering /Software Engineering)

From each stratum, random sampling was used due to time constraint, permission from universities, availability, and willingness of the students. For the present research, the following eleven programs were considered.

Initially it was decided to select at least 50% students from each Science Strata. Out of which 25% would be male and 25% would be female. The students of the first semester and the eighth semester were considered as sample. However, after pilot testing, it was decided to survey only 20% of participants of the whole population. In this way it was decided that from each strata, at least 20% of the students were randomly selected. However, in basic and engineering sciences due to the large availability of the students, more students were surveyed to make our sample reasonably large.

The total population was four thousand eight hundred and seven (4807) students of first (1\textsuperscript{st}) and eighth (8\textsuperscript{th}) semesters of the above mentioned programs.
<table>
<thead>
<tr>
<th>Gender</th>
<th>1&lt;sup&gt;st&lt;/sup&gt;</th>
<th>%</th>
<th>8&lt;sup&gt;th&lt;/sup&gt;</th>
<th>%</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1942</td>
<td>65.74</td>
<td>1216</td>
<td>65.62</td>
<td>3158</td>
<td>65.69</td>
</tr>
<tr>
<td>Female</td>
<td>1012</td>
<td>34.25</td>
<td>637</td>
<td>34.37</td>
<td>1649</td>
<td>34.30</td>
</tr>
<tr>
<td>Total</td>
<td>2954</td>
<td>100</td>
<td>1853</td>
<td>100</td>
<td>4807</td>
<td>100</td>
</tr>
</tbody>
</table>

There were 1942 male students in the 1<sup>st</sup> semester of BS programmes whereas, the number of male students in the 8<sup>th</sup> semester was 1216. Similarly 1012 female students in the 1<sup>st</sup> semester of BS Programmes whereas, there were 637 students in the 8<sup>th</sup> semester.

<table>
<thead>
<tr>
<th>Gender</th>
<th>CIIT</th>
<th>FUUAST</th>
<th>IIUI</th>
<th>NUST</th>
<th>NUML</th>
<th>NU</th>
<th>RIU</th>
<th>IST</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>570</td>
<td>345</td>
<td>974</td>
<td>268</td>
<td>144</td>
<td>624</td>
<td>152</td>
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<td>3160</td>
</tr>
<tr>
<td>Female</td>
<td>301</td>
<td>31</td>
<td>948</td>
<td>212</td>
<td>27</td>
<td>89</td>
<td>8</td>
<td>31</td>
<td>1647</td>
</tr>
<tr>
<td>Total</td>
<td>871</td>
<td>376</td>
<td>1922</td>
<td>480</td>
<td>171</td>
<td>713</td>
<td>160</td>
<td>114</td>
<td>4807</td>
</tr>
</tbody>
</table>

The above table shows the detail of population of the study. It is comprised of students of 1<sup>st</sup> and 8<sup>th</sup> semesters of samples undergraduate BS programmes. The height number of students in sciences were enrolled at IIUI. Second number is of CIIT and least number (i.e. 114) of enrolled science students were at IST.
### Table 3.3  
*Strata wise detail of the Whole Population*

<table>
<thead>
<tr>
<th>Strata</th>
<th>Gender</th>
<th>No.of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Sciences</td>
<td>Male</td>
<td>361</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>854</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1215</td>
</tr>
<tr>
<td>Computer Sciences</td>
<td>Male</td>
<td>1030</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>289</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1319</td>
</tr>
<tr>
<td>Engineering Sciences</td>
<td>Male</td>
<td>1769</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>504</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2273</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>4807</td>
</tr>
</tbody>
</table>

The number of students in the basic sciences were 1215 out of which 361 were male and 854 were female students. The number of students in the computer science strata was 1319 out of which 1030 were male students and 289 were female students. Similarly the number of students in the engineering science strata were 2273 out of which 1769 were male students and 504 were female students.
### Table 3.4  
*University wise Strata of Whole Population*

<table>
<thead>
<tr>
<th>Strata</th>
<th>Gender</th>
<th>CIIT</th>
<th>FUUAST</th>
<th>IIUI</th>
<th>NUST</th>
<th>NUML</th>
<th>NU</th>
<th>RIU</th>
<th>IST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Sciences</td>
<td>Male</td>
<td>75</td>
<td>64</td>
<td>194</td>
<td>28</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>150</td>
<td>24</td>
<td>541</td>
<td>139</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>225</td>
<td>88</td>
<td>735</td>
<td>167</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Sciences</td>
<td>Male</td>
<td>254</td>
<td>109</td>
<td>205</td>
<td>49</td>
<td>46</td>
<td>367</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>61</td>
<td>2</td>
<td>145</td>
<td>17</td>
<td>9</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>315</td>
<td>111</td>
<td>350</td>
<td>66</td>
<td>55</td>
<td>422</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Sciences</td>
<td>Male</td>
<td>241</td>
<td>172</td>
<td>575</td>
<td>191</td>
<td>98</td>
<td>257</td>
<td>152</td>
<td>83</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>90</td>
<td>5</td>
<td>262</td>
<td>56</td>
<td>18</td>
<td>34</td>
<td>8</td>
<td>31</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>331</td>
<td>177</td>
<td>837</td>
<td>247</td>
<td>116</td>
<td>291</td>
<td>160</td>
<td>114</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>871</td>
<td>376</td>
<td>1922</td>
<td>480</td>
<td>171</td>
<td>713</td>
<td>160</td>
<td>114</td>
</tr>
</tbody>
</table>

In the basic science strata, the highest number of enrolled male science students were at IIUI i.e 65 whereas, less number of enrolled male science students were at NUST. Similarly, the highest number of female science students were at IIUI however, less number of female science students were at FUUAST.

In computer science strata, highest number of male science students were at NU, whereas, less number of male science students were in IST. Similarly, the highest number of female science students were enrolled at IIUI whereas, less number of female science students were enrolled at NUML.

In the engineering science strata, highest number of enrolled male science students were at IIUI whereas, less number of enrolled male science students were at IST. Similarly, the highest number of female science students were enrolled in IIUI whereas, less number of female science students were enrolled at RIU.
Table 3.5  

<table>
<thead>
<tr>
<th>Gender</th>
<th>1st</th>
<th>8th</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>368</td>
<td>295</td>
<td>663</td>
</tr>
<tr>
<td>Female</td>
<td>301</td>
<td>258</td>
<td>559</td>
</tr>
<tr>
<td>Total</td>
<td>669</td>
<td>553</td>
<td>1222</td>
</tr>
</tbody>
</table>

|  

Table 3.6 

<table>
<thead>
<tr>
<th>Gender</th>
<th>CIIT</th>
<th>FUUAST</th>
<th>IUI</th>
<th>NUST</th>
<th>NUML</th>
<th>NU</th>
<th>RIU</th>
<th>IST</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>138</td>
<td>135</td>
<td>164</td>
<td>62</td>
<td>48</td>
<td>70</td>
<td>32</td>
<td>14</td>
<td>663</td>
</tr>
<tr>
<td>Female</td>
<td>138</td>
<td>26</td>
<td>276</td>
<td>84</td>
<td>16</td>
<td>7</td>
<td>6</td>
<td>6</td>
<td>559</td>
</tr>
<tr>
<td>Total</td>
<td>276</td>
<td>161</td>
<td>440</td>
<td>146</td>
<td>119</td>
<td>77</td>
<td>38</td>
<td>20</td>
<td>1222</td>
</tr>
</tbody>
</table>

The proportion of male and female students in 1st and 8th semester was almost the same. There were 55% male students in the 1st semester of BS programmes whereas, 54.25% male students were in the 8th semester. Similarly 45% female students were in the 1st semester of BS Programmes whereas, there were 45.74% students were from the 8th semester. The same data has been presented in graphical form.

Figure 3.2  

Pie Chart of the overall distribution of the Whole sample

The above table shows the detail of sample of the study. It is comprised up of students of 1st and 8th semesters of samples undergraduate BS programmes. From COMSATS Institute of Information Technology (CIIT), over all 276 respondents were randomly selected. From Federal Urdu University of Arts Science and Technology (FUUAST), overall 161 respondents were randomly selected, from
International Islamic University Islamabad, overall 440 respondents were randomly selected, from National University of Science and Technology (NUST), overall 146 respondents were randomly selected. Similarly, from NUML, overall 119 respondents were randomly selected, from NU, overall 77 respondents were randomly selected, from RIU, 38 students were randomly selected and from Institute of Space Technology (IST), overall 20 respondents were randomly selected.

![University Wise Detail of Sample](image)

**Figure. 3.3** Bar graph of the University wise Detail of the Whole Sample

This makes a total sample size of 1222 out of the population size of 4807 undergraduate science students. It is a reasonably large sample size of about 25% of the total target population.
As the sample of the study was divided into three kinds of strata therefore, the above table shows detail of respondents in each stratum. In the basic Sciences stratum, total number of students were 478, out of which 158 male students and 320 female students. Similarly in the computer sciences stratum, total number of students were 245 out of which 163 male students and 82 female students. The total number of students in the engineering sciences stratum were 499 out of which 342 were male and 157 were female students. The same data has been presented in graphical form as follows:

![Bar Graph of the Strata wise detail of the Whole Sample](image)

**Figure. 3.4** Bar Graph of the Strata wise detail of the Whole Sample
Here is the detail of locality wise distribution of whole sample.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Semester</th>
<th>Urban</th>
<th>%</th>
<th>Rural</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>1st</td>
<td>239</td>
<td>26.35</td>
<td>129</td>
<td>40.95</td>
</tr>
<tr>
<td></td>
<td>8th</td>
<td>210</td>
<td>23.15</td>
<td>85</td>
<td>26.98</td>
</tr>
<tr>
<td>Female</td>
<td>1st</td>
<td>244</td>
<td>26.90</td>
<td>57</td>
<td>18.10</td>
</tr>
<tr>
<td></td>
<td>8th</td>
<td>214</td>
<td>23.59</td>
<td>44</td>
<td>13.97</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>907</td>
<td>100</td>
<td>315</td>
<td>100</td>
</tr>
</tbody>
</table>

There were 26.35% male students in the 1st semester and 23.15% male students in 8th semester from urban locality. However, in the rural locality, there were 40.95% male students in 1st semester and 26.98% male students in the 8th semester. Similarly, there were 26.90% female students in the 1st semester and 23.59% female students in 8th semester from urban locality. However, in the rural locality, there were 18.10% female students in 1st semester and 13.97% female students in the 8th semester.
<table>
<thead>
<tr>
<th>Strata</th>
<th>Gender</th>
<th>CIIT</th>
<th>FUUAST</th>
<th>IIUI</th>
<th>NUST</th>
<th>NUML</th>
<th>NU</th>
<th>RIU</th>
<th>IST</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Sciences</td>
<td>Male</td>
<td>36</td>
<td>43</td>
<td>65</td>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>95</td>
<td>19</td>
<td>153</td>
<td>53</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>131</td>
<td>62</td>
<td>218</td>
<td>67</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computer Sciences</td>
<td>Male</td>
<td>54</td>
<td>38</td>
<td>22</td>
<td>16</td>
<td>30</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>21</td>
<td>2</td>
<td>42</td>
<td>9</td>
<td>5</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>75</td>
<td>40</td>
<td>64</td>
<td>25</td>
<td>35</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engineering Sciences</td>
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<td>48</td>
<td>54</td>
<td>77</td>
<td>22</td>
<td>30</td>
<td>55</td>
<td>32</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>22</td>
<td>5</td>
<td>81</td>
<td>54</td>
<td>11</td>
<td>4</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>70</td>
<td>59</td>
<td>158</td>
<td>76</td>
<td>41</td>
<td>59</td>
<td>38</td>
<td>20</td>
</tr>
<tr>
<td>Grand Total</td>
<td></td>
<td>276</td>
<td>161</td>
<td>440</td>
<td>146</td>
<td>119</td>
<td>77</td>
<td>38</td>
<td>20</td>
</tr>
</tbody>
</table>

In the randomly selected sample of basic science strata, there were 131 students selected from CIIT, 62 students from FUUAST, 218 students from IIUI and 67 students were selected from NUST.

![Figure 3.5 Bar graph of the University wise detail of the Whole Sample](image)

Figure 3.5 Bar graph of the University wise detail of the Whole Sample
In the randomly selected sample of computer science strata, there were 75 students selected from CIIT, 40 students were selected from FUUAST, 64 students from IIUI, 25 students from NUST, 35 students from NUML and 18 students from NU.

In the randomly selected sample of Electrical Engineering strata, there were 70 students selected from CIIT, 59 students were selected from FUUAST, 158 students from IIUI, 76 students from NUST, 41 students from NUML, 59 students from NU, 38 students from RIU and 20 students were selected from IST.
## Table 3.10  Program wise detail of Whole Sample

<table>
<thead>
<tr>
<th>Prog.</th>
<th>Gender</th>
<th>CIIT</th>
<th>FUUST</th>
<th>IIUI</th>
<th>NUST</th>
<th>NUML</th>
<th>IST</th>
<th>NU</th>
<th>RIU</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS PHY.</td>
<td>Male</td>
<td>14</td>
<td>43</td>
<td>17</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>74</td>
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<tr>
<td></td>
<td>Female</td>
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<td>19</td>
<td>36</td>
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<td>53</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
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<td>6</td>
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<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td></td>
<td>Female</td>
<td>26</td>
<td>65</td>
<td>15</td>
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<td></td>
<td></td>
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<td>77</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>131</td>
</tr>
<tr>
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<td>Male</td>
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<td>36</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Total</td>
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<td>208</td>
</tr>
<tr>
<td>BS CS</td>
<td>Male</td>
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<td>38</td>
<td>22</td>
<td>16</td>
<td>18</td>
<td>15</td>
<td></td>
<td></td>
<td>163</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>21</td>
<td>2</td>
<td>42</td>
<td>9</td>
<td>5</td>
<td>3</td>
<td></td>
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<tr>
<td></td>
<td>Total</td>
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<td>64</td>
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<td>18</td>
<td></td>
<td></td>
<td>245</td>
</tr>
<tr>
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<td>Male</td>
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<td>54</td>
<td>27</td>
<td>23</td>
<td>22</td>
<td>14</td>
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<td></td>
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<td>34</td>
<td>29</td>
<td>20</td>
<td>59</td>
<td>38</td>
<td>334</td>
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<tr>
<td>BS CE</td>
<td>Male</td>
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<td></td>
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<td>84</td>
</tr>
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<td></td>
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<td>Total</td>
<td>24</td>
<td>109</td>
<td>20</td>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>165</td>
</tr>
<tr>
<td>Horizontal Total</td>
<td>276</td>
<td>161</td>
<td>440</td>
<td>146</td>
<td>64</td>
<td>20</td>
<td>77</td>
<td>38</td>
<td>1222</td>
<td></td>
</tr>
</tbody>
</table>

The table 3.10 shows the detail of students in each programmes in sampled Universities/DAI. Here is the description of each program in sampled Universities/DAIs.

**CIIT**

In BS Physics programme, there were 14 male students and 10 female students. In BS Math programme, there were 7 male and 26 female students. In BS Biosciences, there were 15 male and 59 female students. In BS computer Science, there were 54 male
and 21 female students. In computer engineering, there were 17 male students and 7 female students. In BS electrical engineering/telecom engineering, there were 31 male students and 15 female students.

**FUUST**

There were 43 respondents in the BS Physics programme where as there were 19 female in this programme. In the BS Computer Science department, there were 38 male and 2 female students. There were 54 male and 5 female students in the electrical engineering programme.

**IIUI**

In IIUI, there were 17 male students in the BS Physics programme whereas, there were 36 female students in this programme. In BS mathematics programme, there were 12 male students and 65 female students. In BS biosciences programme, there were 36 male students and 52 female students. In BS Computer science programme, there were 22 male and 42 female students. There were 27 male students and 22 female students in the electrical engineering programme. In BS computer/software engineering programme, there were 50 male students, and 59 female students.

**NUST**

In BS Math programme, there were 6 male students and 15 female students. In the BS Bioscience programme there were 8 male students and 38 female students. In BS Computer science programme, there were 16 male and 9 female students. In Electrical engineering programme, there were 23 male students and 11 female students. In BS software engineering programme, there 9 male students and 11 female students.

**NUML**

In computer science programme, there 18 male students and 5 female students. There were 29 students in the electrical engineering programme, out of which, there were 22 male students and 7 female students. In the software engineering programme, there were 8 male students and 4 female students.

**IST**

In electrical engineering programme, there were 14 male students and 6 female students.
138

NU (FAST)
In computer science programme, there were 15 male students and 3 female students and in the electrical engineering programme, there were 55 male students and 4 female students.

RIU
In the electrical engineering programme, there were 32 male and 6 female students.

3.7 Pilot Testing

The pilot testing was done in the evening programmes of Federal Urdu University of Science and Technology. There were two reasons for pilot testing; first reason is to identify the problems regarding administration of research instruments, secondly to estimate time consumed for data collection and third to find out the reliability of the instruments. There were three research tools for the study. Two research tools were about cognitive styles and one questionnaire was used to find out science related attitude. Out of three tools, two research tools were based upon specified time. It was revealed during pilot testing that large number of participants were not manageable for such tests. Secondly the registration number was not mentioned in the questionnaire which could create problem to obtain academic achievement of students after the exams of students.

After pilot testing, registration number was included in the questionnaire. It was experienced that the students of 8th semesters were busy in different projects therefore, it was difficult to contact them and engage them in the study. The researcher had to contact and visited a single university several times for a single program because the students were not readily available. Therefore, Pilot testing provided ideas to device strategies to conduct actual research.

After pilot testing, it was revealed that as two tests were time based therefore, 50% data collection would not be manageable and possible. Factors such as expense, time, and accessibility frequently prevent researchers from gaining information from the whole population. Therefore, it was decided with the mutual consent of
supervisor that overall 25% students from three strata would be selected as sample. As the population is homogeneous in terms of programs and semesters therefore, stratified random sampling was used to select participants from each stratum.

3.8 Instruments

In the present study, for data collection, three Research instruments were used. A covering page was designed for obtaining the necessary demographic data from respondents. Here is the detail of it.

3.8.1 Demographic Inventory. The demographic data of students was obtained by demographic inventory (Appendix- H). It contained the following information from students:

i. Name of student

ii. Session

iii. Registration No.

iv. Institution/University

v. Gender

vi. Age

vii. Location

viii. Semester

ix. Marks obtained in HSSC by the student

x. Subject studied in HSSC

xi. Who guide to choose BS programme

xii. Qualification of father
The following three research instruments were used for data collection from the respondents.

1. Test to measure Convergent/ Divergent learning style
2. Test to measure Field Dependence/Field Independence
3. The science related attitude scale

### 3.8.2 Field-Dependent/ Field-Independent Test

Field-Dependence or Independence is the perceptual component of a particular cognitive style. Therefore, in order to identify the Field-Dependent or Filed independent cognitive learning styles of students, Hidden Figure Test (SHAPES) was administered. The purpose of applying this test was to measure the degree of Field-Dependence/Field-Independence of each student in the sample. (Appendix-I)

#### 3.8.2.1 Hidden Figure Test/SHAPES

In the past a Hidden Figure Test was developed at the center for Science Education, Glasgow University based on Witkin and his followers’ work (1974, 1978, 1979, and 1981). The test items were designed and used by El-Bana (1981) (quoted by Cataloglu and Ate, 2015) for the first time; the same test was used by Al-Naeme (1991) and other researchers. Zaman (1996) has also used the same test with necessary modifications and the name of SHAPES was given by the researcher. This HFT Test was composed of eighteen complex figures, apart from two figures used for examples. There were six simple shapes which were embedded in the eighteen complex figures (only one simple shape in each figure) and the students have to isolate these shapes.

Two examples were used in the first two pages of the test booklet; six simple shapes were located in the third page of the booklet as a specimen of the type to be
found. Subjects were required to find a hidden simple shape in each complex figure. They had then to outline it in pencil for pen against the lines of the complex figures. There were some conditions in the HFT which were had to be followed.

The Hidden Figure Test was used in this study has been revised under the supervision of Dr. Peter McGuire. The revised version of HFT is named as “SHAPES” and is now available for the use of researchers at the Center for Science Education, Glasgow University. The test is presented in the Appendix-I. The test “SHAPES” is composed of twenty item (complex figures), apart from two other figures used for examples. There are eight simple geometric and non-geometric shapes, which are embedded in twenty complex figures.

On the first two pages of the test booklet, two examples are presented. The specimen of simple shapes was shown on the last page of the booklet. From the third page, the arrangement of twenty items (complex figures) was based on an easy to complex approach i-e the first four items had low difficulty level then the next four had high difficulty levels, and the next four complex figures had a low difficulty level and the next items are difficult and so on until the twentieth item. This is important approach, used by Witkin and his followers.

Time specified for this test is fifteen minutes all together, five minutes for examples to read and understand the instructions and ten minutes for twenty items i-e half minute to trace one simple shape into each complex item. The subjects are required to outline the simple shape in pen/pencil in the lines of the complex figures.

3.8.2.2 Necessary Conditions for SHAPES. The students were required to trace the simple shapes from the complex figures within certain conditions which are described here.

1. The simple shape when it appears within the complex figure is always the same size, has the same proportion, and faces in the same direction as it is shown alone, on the last page of the booklet.
2. There are many simple shapes embedded in each complex figure, but the simple shape which is required appears only once. Thus the students were required to trace the particular simple shape in to the particular complex item, exactly
as it is shown on the last page of the booklet.

3. The students were not allowed to use any means to measure the size of the simple shape embedded in the complex figure.

4. The students were allowed to refer to the last page of the simple shapes as often as necessary.

5. Strictly fifteen minutes were allowed for this test.

3.8.2.3 Scoring of SHAPES. Apart from first two examples, the first four (complex figures) items of the test were used as practice items. The sixteen remaining items were used for scoring.

The main scoring scheme which is used for the “SHAPES” / Hidden Figure Test is to give one point for finding a correct simple shape embedded in a complex figure. The overall sum of these scores is the total marks which a student can gain. The possible maximum score that can be obtained is sixteen.

To separate the sample into categories of field, the researcher used a formula. This formula as quoted by Zaman (1996) has been used a criterion by Scaramalia (1977), Case (1974), Case and Golberson (1974), Al Naeeme (1991). Zaman (1996) and many other researchers according to the formula (criterion) students with a score of at least a half standard deviation above the mean score of the sample population are considered to be in the category of Field-Independents, the student who achieved a score less than a half standard deviation below the mean score are classified as Field-Dependents, and the students between these two categories were named as field- intermediates.

In mathematical terms:

\[ F.D \leq \mu - \frac{1}{2} (\sigma) \]

\[ F.Int = \mu \pm \frac{1}{2} (\sigma) \]

\[ F.I \geq \mu + \frac{1}{2} (\sigma) \]

Where \( \mu \) is the mean and \( \sigma \) is the standard deviation.
In practice students in the bottom third of the group were classified as field – dependent while those in the top third were Field-Independents.

The number of students who fall into each group have been described in chapter 4.

Table 3.11 *Descriptive Statistics for Field-Dependent-Field-Independent Learning Style (F.D-F.I)*

<table>
<thead>
<tr>
<th>n</th>
<th>Range</th>
<th>Mean</th>
<th>Std.Dev</th>
<th>Variance</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1222</td>
<td>16</td>
<td>6.46</td>
<td>3.75</td>
<td>14.093</td>
<td>0.588(0.070)</td>
<td>-0.552(0.140)</td>
</tr>
</tbody>
</table>

The total number of respondents were 1222, the range of the scores was 16 , the mean value of all the scores was 6.4574 , the standard deviation was 3.75273 and the variance was 14.093. The same data has been represented in the form of distribution curve (Bell curve). Although it shows skewness however, due to large sample size, small departures from normal w.r.t skewness and Kurtosis are not important. As we can invoke central limit theorem in such cases. The values of skewness and kurtosis alongwith errors have been shown in the above table.

*Figure 3.6 Bell Distribution of Field-Dependent-Field-Independent Learning Style of the Whole Sample*

The respondents were classified into Field-Dependent, Field Intermediate and Field-Independent population by applying formulae (Zaman, 1996). The calculation
of the results of the Field-Dependent/Field-Independent cognitive learning style test is as follows. Formal written permission was obtained for the use of this test (Appendix-G).

3.8.2.4 Field-Dependent / Field-Independent Calculation of the Whole Sample. The whole sample was classified into Field-Dependent, Field Intermediate and Field-Independent categories by using the above mentioned formula. However, keeping in view the population of the present study, instead of \( \frac{1}{4} \) S.D, 1 S.D was used.

Field-Dependent \( \leq \) mean – 1 (S.D)
\[ \leq 6.4574 - 1(3.75273) \]
\[ \leq 6.4507 - 3.7527 \]
\[ \leq 2.704 = 3.0 \]

Field Intermediate = mean ± 1 (S.D)
\[ = 6.4574 \pm 1(3.75273) \]
\[ = 6.4574 \pm 3.75273 \]
\[ = 6.4574 - 3.75273 = 2.704 = 3 \]
\[ = 6.4574 + 3.7573 = 10.210 = 10 \]

Field-Independent \( \geq \) mean + 1 (S.D)
\[ \geq 6.4574 + 1(3.75273) \]
\[ \geq 6.4574 + 3.75273 = 10.210 = 10 \]

The students having scores less than or equal to 3 were categorized as Field-Dependents whereas, the students having scores between 3.0 and 10.02 were categorized as Field-Intermediate and the students having scores greater than or equal to 10.02 were categorized as Field-Independents.
3.8.3 Convergent/Divergent Test. To identify the cognitive learning styles of students, convergent / divergent test was used. This test was developed and evaluated by Bahar, Johnstone, and Hansell (1999) at the Centre for Science Education University of Glasgow, UK. This test is based upon the Hudson’s Test (1966). This test has been used by many researches such as Bhatti (2013), Zaman (2006), Hindal, Reid and Whitehead (2008), Danilli and Reid (2004) and Bahar et al (1999). This test is mainly used to identify convergers and divergers. Formal written permission was obtained for the use of this test (Appendix-G).

This test is comprised up of six mini-tests (Appendix-J).

The detail of the test is as follows:

**Test-1:** This test was designed in order to find out student’s ability to think of as many words as possible having the same or similar meaning to the one, which is given. An example is provided at the beginning of the test to clarify what the student is required to do. The time limit that has been set up for this test is four minutes.

**Test-2:** The students were asked in this test to write as many sentences as possible comprising of four given specific words in each sentence. These given words should be used in any constructive sentence in the same order in which they were written in the test. Again, an example is provided at the beginning of the test, and four minutes were set as the time for this test.

**Test-3:** Most convergent/ divergent tests are verbal. It is prudent to mention that verbal tests could prove arduous for some students, especially those who have difficulty in language or writing and therefore, pictorial test may be considered as an opportunity for such students to express easily their own ideas and imaginations. Hence, in test-3 students were required to draw up to five symbols for each word or phrase given. Five minutes was the limit for this test and one example was also provided to illustrate the test.

**Test-4:** This test is intended to reflect students thinking ability about the subject. The students were asked to write all the things “which are round or which are round more often than any other shape”. The time limit is two minutes, and the students are given an example at the beginning of the test to illustrate what is required from them.
Test-5: It is similar to test-4 in reflecting students thinking ability. The students were required to think about various words, which begin with the letter ‘G’, and end at the letter T, names of people or places are not allowed. An example is given for this test for practice. Two minutes were allowed for completion of this test.

Test-6: It is a free imagination test. Student were given a specific topic and asked to write as many ideas as they can about such a topic without any restrictions, this test may make demands upon the student’s ability in composition and imagination, an example is provided at the beginning of the test, and three minutes were given as the time limit.

3.8.3.1 Scoring of Convergent/Divergent Test. For each question, there was no obligation for the students to write as many answers as they can write. The time allowed to solve this test was 20 minutes. One mark was allocated for every single correct answer. The maximum possible score of these tests could be 130.

In mathematical terms:
The Convergent $\leq$ mean $- \frac{1}{4}$ (S.D)
Normal (all-rounder) = mean $\pm \frac{1}{4}$ (S.D)
Divergent $\geq$ mean $+ \frac{1}{4}$ (S.D)

The learning styles of the whole sample were identified with the administration of convergent–divergent test. The tests were scored according to scoring procedure.

The results of the tests were assessed and following statistics were obtained. The test was not translated into Urdu for the Pakistani sample because English language is medium of instruction.

<p>| Table 3.12 | Descriptive Statistics for Convergent-Divergent Learning Style Test |
|---|---|---|---|---|---|---|</p>
<table>
<thead>
<tr>
<th>n</th>
<th>Range</th>
<th>Mean</th>
<th>Std.Dev.</th>
<th>Variance</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1222</td>
<td>101</td>
<td>47.15</td>
<td>18.091</td>
<td>327.315</td>
<td>0.385(0.070)</td>
<td>-0.073(0.140)</td>
</tr>
</tbody>
</table>

The total number of respondents were 1222, the range of the scores was 101 ,the mean value of of all the scores was 47.1538, the standard deviation was 18.09184 and
the variance was 327.315. on the basis of this statistical calculation, the normal
distribution was emerged out as follows (Fig.3.9)

\[ \text{Figure 3.7 Bell distribution of marks regarding convergent-divergent learning style of} \]
\[ \text{the whole sample} \]

The respondents were classified into Convergent/ Divergent and Normal by applying
formulae (Zaman, 2006). The calculation of the results of the convergent-divergent
learning style test is as follows.

**3.8.3.2 Convergent / Divergent calculation of the Whole Sample.** The whole
sample was classified into convergent, normal, and divergent categories by using the
above mentioned formula. However, for the present study, 1 S.D was used instead of
\( \frac{1}{4} \) S.D.

**The Convergent**
\[ \leq \text{mean} - 1(\text{S.D}) \]
\[ \leq 47.15 - 1(18.08) \]
\[ \leq 47.15 - 18.08 \]
\[ \leq 29.06 \]

**Normal (all-rounder)**
\[ = \text{mean} \pm 1(\text{S.D}) \]
\[ = 47.15 \pm 1(\text{S.D}) \]
\[ = 47.15 \pm 18.08 \]
\[ = 47.15 - 18.08 = 29.06 \]
\[
Divergent \geq mean + 1 \text{ (S.D)} \\
\geq 47.15 + 1 \text{ (18.08)} \\
\geq 47.15 + 18.08 \\
\geq 65.23
\]

Hence, the students having scores less than or equal to 29.06 were placed in the class of convergent and the students having scores between 29.06 and 65.23 were placed in the category of Normal (all-rounder) and the students having scores 65.23 and above were placed in the category of Divergent.

### 3.8.4 Attitude Questionnaire.

For this study, attitude questionnaire was developed to identify science related attitude of science students. The attitude questionnaire was based upon five point Likert scale, ranging from strongly disagree to strongly agree. This scale was helpful for identifying the direction of attitude (positive or negative towards science) and strength (strongly agree- strongly disagree) of their attitude.

Several researchers have developed different tools to find the attitude towards science. The description of few attitude scales is as follows:

- An attitude scale developed by Fennema and Sherma in 1970. It had four subscales:
  1. Confidence scale
  2. Usefulness scale
  3. A scale that measures science as male domain
  4. Teacher’s perception scale

  Each scale consists of 12 items; there were 6 positive and 6 negative statements.
  Total number of items in the scale were 48.

- Another very famous scale was developed by Fraser in 1981. The name of the tool was TOSRA (Test Of Attitudes). It consisted of 7 subscales such as:
  1. Enjoyment science/science lessons
  2. Social implications of science
3. Normality of scientists
4. Attitudes towards scientific inquiry
5. Attitudes towards scientists
6. Career interest in science
7. Leisure interest in science
There were a total of 60 number of items in TOSRA.

- SAI (Scientific Attitudes Inventory) was introduced by Moore and Foy in 1997. The original scale consisted of 60 items based on Likert scale. There were half positive statements and half negative statements. The revised version of SAI was presented in 1996. It consisted of 40 statements and there are three subscales of it:
  1. Science is about understanding
  2. Science is rigid
  3. I want to be a scientist
- A science attitudes questionnaire was developed in Britain for the use of secondary school students. It consisted of 58 five choice Liker type items with five subscales:
  1. science interest
  2. social implications of science
  3. learning activity
  4. science teachers
  5. school
- There are many other scales of attitudes towards science scales available in the research literature pertaining to science education. Here is one example of it. An attitude with the title of “Modified Attitude Towards Science Inventory “is available on internet. It consisted of 25 items .There are five subscales of this inventory:
  1. perception of science teachers
  2. anxiety towards science
  3. value of science in society
  4. self-concept of science
  5. desire to do science

3.8.4.1 Science related Attitude Questionnaire for Present Study. Keeping in view the objectives of the study, a science related attitude questionnaire has been developed. Several relevant instruments have been viewed for the development of this questionnaire. Therefore, an eclectic approach has been used. Initially an item pool of 76 items was developed. The science related attitude scale consisted of 76-
items. It was given to the experts for validation (Appendix-D). Such items whose validity was poor were either deleted or modified. The final scale was validated from experts (Appendix-E) and consisted of 40 items. The final scale is a self-report scale that consists of five subscales with a 5-point Likert scale (1 = strongly disagree; 2 = disagree, 3 = neutral/undecided; 4 = agree and 5 = strongly agree). (Annexure-K)

This instrument consists of the following four subscales:

1. Utilitarian Aspect (Use of science in daily life, onwards study)
2. Career Interest In science
3. Personal interest aspect (enjoying class lessons, desire to do science)
4. Engagement in Science Related Activity (Leisure interest in science)

Each scale has five positive and five negative statements. Description of each subscale is given below.

1. The Utilitarian Aspect will measure the science related attitude of students for the use of science in daily life. It also measures their science related attitude for the onwards study in science.
2. The career interest in science will measure the science related attitude of students in science related careers in their future planning.
3. The personal interest aspect will measure the science related attitude of students for the desire to do science themselves and their enjoyment in class lessons.
4. The engagement in science related activity will measure their science related attitude towards their leisure interest in science.
Table 3.13  Scale Allocation and Scoring For each Item

<table>
<thead>
<tr>
<th>Utilitarian Aspect</th>
<th>Career Interest In Science</th>
<th>Personal Interest</th>
<th>Engagement In Science Related Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(+)</td>
<td>2(-)</td>
<td>3(+)</td>
<td>4(-)</td>
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<tr>
<td>5(-)</td>
<td>6(+)</td>
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<td>36(-)</td>
</tr>
<tr>
<td>37(-)</td>
<td>38(+)</td>
<td>39(-)</td>
<td>40(+)</td>
</tr>
</tbody>
</table>

For positive items (+), responses SDA, DA, N, A, SA were scored 1, 2, 3, 4, 5 respectively. The scoring of negative items was inverted.

3.8.5 Academic Achievement Test Results. In order to find relationship of cognitive learning styles of students with their academic performance, the results of their academic achievement were obtained from their relative universities/DAI’s. The academic achievement results were obtained after one semester from their respective universities/DAI’s.

3.9 Reliability of Research Instruments

According to Scott and Morrison (2007), “reliability is used as a measure of quality and the term means repeatability or consistency. A measure is reliable if it provides the same results on two or more separate occasions, when the assumption is made that the object being measured has not changed. Thus, for quantitative educational researchers, if a measure or indeed series of measures when repeated give similar results, it is possible to say it has high reliability” (p.208).

In literature, there are different findings and opinions regarding reliability of cognitive tests. Danilli and Reid (2006) used Hidden Figure Test and Convergent
Divergent test in a study and argued that “the cognitive tests were based on well-established techniques. The field dependency test was almost identical to that of Witkin et al. (1971) test” (p.73).

Similarly, Goldman, Osborn and Mitchell (1996) as quoted by Study (2012) have reported the reliabilities of several cognitive spatial ability tests e.g. the Kuder-Richardson coefficient of card rotation test was 0.72, the Spearman-Brown correlation yields a coefficient of 0.68 for Gestalt completion test, Kuder Richardson coefficient was 0.76 for Hidden Figure test, the reliability of revised Minnesota paper form board test found out by Kuder Richardson coefficient was 0.61, the reliability of Raven’s Progressive Matrices Test by test-retest reliability coefficient range from 0.76 to 0.91. Similarly the reliability of the punched Holed test found out Kuder Richardson coefficient was 0.68, the reliability of Surface Development Test found out by Kuder Richardson coefficient was 0.84.

Boersma (1968) studied the test-retest reliability of the CF-1 hidden figures test. Students were given the CF-1 hidden figures test on two occasions, separated by a 10-week period. The test-retest reliability was found to be 0.63 for total mean scores between administrations of tests.

According to Olman (1968) as quoted by Thomaas and Hersen (2006), the reliability of Portable Rod and Frame Test (RFT) (a measure of field dependence–field independence) was found out by Spear Brown using split half reliability which came to be 0.95. Jacobs, Byrd and High (1985) used alternate form reliability to find reliability of the Hidden Figure test.

Ary, Jacobs, Razavieh, Sorensen (2009), defined test –retest reliability as “an obvious way to estimate the reliability of a test is to administer it to the same group of individuals on two occasions and correlate the two sets of scores. The coefficient obtained by this procedure is called a test-retest reliability coefficient” (p.242).

After analyzing the views of several authors and different kinds of reliabilities used for cognitive tests, the researcher decided to find out the reliabilities of the three
questionnaires i-e convergent-divergent, Field-Dependent-Field-Independent and science related attitude scale of the present study from pilot testing. Although both cognitive style tests i-e Field-Dependent-Field-Independent and convergent-divergent were standardized, even then it was decided to find their reliability in the Pakistani norms. Therefore, test-retest reliability was found out for the two cognitive tests. Moreover Cronbach Alpha reliability coefficient was computed for science related attitude scale.

During pilot testing in FUUAST, the test retest reliabilities of the Field-Dependent-Field-Independent test (SHAPES) and convergent-divergent tests were measured by administering the same test twice i-e with a gap of three weeks. The total number of respondents was 30 i-e 10 students from BS Physics, 10 from BSCS and 10 students of BSEE. The test-retest reliability of the convergent-divergent test was computed using procedure given below.

3.9.1 Test Retest Reliability of Convergent Divergent Test

\[X = \text{Scores of Convergent Divergent test (Test)}\]

\[Y = \text{Scores of Convergent Divergent test (Re-Test)}\]

Mean Value of \(X\) = 60.03

Mean value of \(Y\) = 64.9

\[x = \text{mean value of } X - \text{value of } X\]

\[y = \text{mean value of } Y - \text{value of } Y\]
Table 3.14 Computation of Test Retest Reliability of Convergent Divergent Test

<table>
<thead>
<tr>
<th>Sr.#</th>
<th>X</th>
<th>Y</th>
<th>x</th>
<th>Y</th>
<th>x²</th>
<th>y²</th>
<th>xy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>66</td>
<td>67</td>
<td>6.0</td>
<td>2.1</td>
<td>36</td>
<td>4.41</td>
<td>12.6</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>80</td>
<td>20.0</td>
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<td>400</td>
<td>228.01</td>
<td>302.0</td>
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<tr>
<td>3</td>
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<td>73</td>
<td>9.0</td>
<td>8.1</td>
<td>81</td>
<td>65.61</td>
<td>72.9</td>
</tr>
<tr>
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<td>51</td>
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<td>-13.9</td>
<td>289</td>
<td>193.21</td>
<td>326.3</td>
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<td>113.7</td>
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</tr>
</tbody>
</table>

Pearson Correlation Coefficient: 

\[ r = \frac{\sum xy}{\sqrt{\sum x^2 \sum y^2}} \]

\[ r = \frac{3411.1}{3630.81} \]

\[ r = 0.939 \approx 0.94 \]

154
3.9.2 Test Retest Reliability of Hidden Figure Test

X=Scores of Hidden Figure test (Test)

Y= Scores of Hidden Figure test (Re-Test)

Mean Value of X= 6.9

Mean value of Y= 7.8

x=mean value of X – value of X

y=mean value of Y – value of Y

Table 3.15 *Computation of Test Retest OF Field-Dependent-Field-Independent Learning Style*

<table>
<thead>
<tr>
<th>Sr.#</th>
<th>X</th>
<th>Y</th>
<th>x</th>
<th>y</th>
<th>x²</th>
<th>y²</th>
<th>xy</th>
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<td>0.2</td>
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<td>1.21</td>
<td>4.84</td>
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<td>2.2</td>
<td>1.21</td>
<td>4.84</td>
<td>2.4</td>
</tr>
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</table>
Pearson Correlation Coefficient =

\[ r = \frac{\sum_{i=1}^{n} x_i y_i}{\sqrt{\sum_{i=1}^{n} x_i^2} \sqrt{\sum_{i=1}^{n} y_i^2}} \]

\[ = \frac{236.7}{\sqrt{(241.9)(254.2)}} \]

\[ r = 0.954 \approx 0.95 \]

### 3.9.3 Alpha Reliability of Science related Attitude Scale

As described earlier that Likert scale of five points had been used for the present study. Gliem and Gliem (2003) stated that “when using Likert Type scales, it is imperative to calculate and report Cronbach’s alpha coefficient for internal consistency reliability for any scales or subscales one may be using. The analysis of the data then must use these summated scales or subscales and not individual items. If one does otherwise, the reliability of the items is at best probably low and at worst unknown. Cronbach’s alpha does not provide reliability estimates for single items” (p.88). For the present study Cronbach Alpha reliability coefficient was measured for science related attitude scale.

Therefore, in order to find out the reliability of the science related attitude scale, the Cronbach alpha was used. The pilot testing was done in FUUAST. The number of students who participated in science related attitude pilot testing was 80. These students were not included in the sample. According to Wiersma and Jurs
(1990), many of the reliability coefficients computed for educational tests are based on a single test administration. The items and their scores are then divided in some manner, such as splitting the test into two halves, and a measure of internal consistency reliability is computed. Measures of internal consistency are measures of equivalence reliability i.e. the extent to which the parts of the tests are equivalent. The advantages of having to administer only one test at a time greatly facilitate reliability estimation.

Cronbach (1951) developed a more generalized reliability coefficient called Cronbach Alpha or just Alpha, designated by $r_\alpha$, which is based on parts of a test. The formula for $r_\alpha$, involves variances of the parts of the test and is given by:

\[
\alpha = \frac{n}{n-1} \left(1 - \frac{\sum S_i^2}{S^2}\right)
\]

\[n=\text{number of parts in which test is divided}\]

\[S_i = \text{variance of jth part, and}\]

\[S^2 = \text{variance of the total score}\]

<table>
<thead>
<tr>
<th>Table 3.16</th>
<th>Alpha Reliability of the Science related Attitude Scale from Pilot study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cronbach’s Alpha</td>
<td>Cronbach’s Alpha Based on Standardized Items</td>
</tr>
<tr>
<td>0.878</td>
<td>0.886</td>
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</tbody>
</table>

The reliability value of Cronbach alpha for attitude scale administered while Pilot testing was 0.878.
Table 3.17  
*Inter Construct Correlation of science related Attitude subscales for Pilot Study*

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Utilitarian</th>
<th>Career</th>
<th>Personal Interest</th>
<th>Engagement In Science related activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilitarian</td>
<td>1.000</td>
<td>.688</td>
<td>.687</td>
<td>.574</td>
</tr>
<tr>
<td>Career</td>
<td>.688</td>
<td>1.000</td>
<td>.598</td>
<td>.499</td>
</tr>
<tr>
<td>Personal Interest</td>
<td>.687</td>
<td>.598</td>
<td>1.000</td>
<td>.686</td>
</tr>
<tr>
<td>Engagement in science related activities</td>
<td>.574</td>
<td>.499</td>
<td>0.686</td>
<td>1.00</td>
</tr>
</tbody>
</table>

There were four constructs of the science related attitude scales. These include Utilitarian, Career, personal Interest, and Engagement in Science. The correlation of utilitarian with career was found to be 0.688, the correlation of the utilitarian with personal interest found to be 0.687, the correlation of utilitarian and engagement in science was 0.574. Similarly the correlation between career and personal interest was 0.598, the correlation between career and engagement in science related activities 0.499.

Table 3.18  
*Alpha Reliability of the Science related Attitude Scale from whole sample*

<table>
<thead>
<tr>
<th>Cronbach’s Alpha</th>
<th>Cronbach’s Alpha Based on Standardized Items</th>
<th>No. of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.911</td>
<td>0.913</td>
<td>40</td>
</tr>
</tbody>
</table>

The reliability value of Cronbach alpha for science related attitude scale administered to the whole sample was 0.913.
Table 3.19 *Inter Construct Correlation of science related Attitude scale for the whole sample*

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Utilitarian</th>
<th>Career</th>
<th>Personal Interest</th>
<th>Engagement In Science related activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utilitarian</td>
<td>1.000</td>
<td>.679</td>
<td>.615</td>
<td>.554</td>
</tr>
<tr>
<td>Career</td>
<td>.679</td>
<td>1.000</td>
<td>.612</td>
<td>.563</td>
</tr>
<tr>
<td>Personal Interest</td>
<td>.615</td>
<td>.612</td>
<td>1.000</td>
<td>.689</td>
</tr>
<tr>
<td>Engagement in science related activities</td>
<td>.554</td>
<td>.563</td>
<td>0.698</td>
<td>1.00</td>
</tr>
</tbody>
</table>

There were four constructs of the science related attitude scale. These include Utilitarian, Career, Personal Interest, and engagement in science. The correlation of utilitarian with career was found to be 0.679, the correlation of the utilitarian with personal interest found to be 0.615, the correlation of utilitarian and engagement in science was 0.554. Similarly the correlation between career and personal interest was 0.612, the correlation between career and engagement in science related activities 0.563. The correlation between personal interest and engagement in science related activity was 0.689.

3.10 Data Collection

The data was collected by administering the questionnaires on the selected sample. The data was collected through demographic inventory, Convergent/Divergent test, and SHAPES were administered to the students. The cognitive learning styles were identified using Convergent/Divergent test, and SHAPES. The academic achievement of undergraduate science students was also obtained from respective universities.
3.10.1 Data Collection Procedure.

In order to collect the data, the following procedure was adopted:

Initially, a formal letter for data collection was obtained from Dean FHS (NUML). The same letter (Appendix-B) was also got signed by the registrar NUML so that data could be obtained from NUST and IST. A letter from supervisor was also obtained for the data collection. The formal permission was then obtained from the sampled universities for data collection. Academic coordinators/program officers were contacted telephonically, through email and personally for obtaining time tables and list of students and availability of students. The academic coordinators and class representatives were contacted to find the available time of the students. Researcher also personally contacted class representatives (CRs) for the availability of the respondents for data collection. Due to their cooperation and arrangements data collection was done smoothly.

In the second step, students were briefed about the tests which were used to collect the data. The instructions were given to the students regarding tests. The demographic inventory, Convergent/Divergent test, and SHAPES were administered to the students.

In the third step, the same students were contacted in the next available time to get their opinion about science related attitude. The science related attitude of students was obtained by science related attitude scale. In the fourth step, all these inventories/tests were then put together and codified.

Two research assistants were engaged in order to get the data from the respective sample in the planned time. These researchers were trained and briefed about data collection. These assistants helped the researcher to get the data from IIUI (male campus) and IST (which locates outside the periphery of the city). Due to this strategy, data was collected from multiple universities simultaneously. Finally, the exam results were obtained at the end of the semesters (1st and 8th). The examination departments of the sampled universities as well as concerned departments were
consulted for getting the CGPA of those students who took part in the study.

Proper follow up was done during data collection. The class representatives, teachers, head of departments and academic coordinators were contacted personally, telephonically, by mobile messaging and by sending emails. Where necessary, several visits were made for each class /each program. Proper scheduling was done for data collection.

3.11 Data Analysis

The tests were coded and then data was entered in the SPSS software. It was then analyzed by applying standardized statistical techniques and hypotheses were tested using Chi-Square and t-test. As there were two types of data i-e qualitative and quantitative, therefore, Chi- Square was used for qualitative data and t-test was used for quantitative data respectively.

Chi-Square test was used where the researcher have to find the interdependence of variables as Chi-Square is test of interdependence so it help out to check the dependency. Moreover, Chi-square test deals with the frequencies of the data therefore, in order to find the difference between variables ,chi-square test was used. Whereas, t-test was used for the purpose of determining the difference between the means as in this research various objectives were formulated to find the difference between the means of variables, therefore, t-test was used in this situation.

Initially, in order to comprehend the formulae, the data was analyzed was analyzed manually. Afterwards SPSS was used for data analysis. The data was tabulated and graphs were used to present the data.

3.12 Time

It was planned to collect data of the 1st semesters and 8th semester. As most of the first semesters are being offered during Fall semester. Therefore, the 1st semester data was collected during fall 2013 and the data from students of 8th semesters was collected during spring 2014. The results of the first semester were obtained during
spring 2014. Similarly the results of the 8th semesters were also obtained after spring 2014. The analysis of data has been presented in Chapter 4.
CHAPTER 4

ANALYSIS AND INTERPRETATION OF DATA

In this research study, a survey was conducted to know the cognitive learning styles and science related attitude of undergraduate science students. Moreover, the science student’s academic achievement was also explored.

The population of the study consisted of undergraduate science students studying in the universities/Degree Awarding Institutes (DAIs) of Islamabad. Stratified random sampling was adopted and three strata were constituted i-e basic sciences (including BS Physics, BS Mathematics, BS Biosciences), computer sciences (BS Computer Sciences) and engineering sciences (BS Electrical Engineering, Computer Engineering).

Four types of cognitive learning styles were taken into consideration i-e Convergent-Divergent cognitive learning style and Field-Dependent/ Field-Independent cognitive learning styles. These cognitive learning styles were identified by administering two different tests which have already implied in several researches. A science related attitude scale was developed by keeping in view the objectives of the study. Student’s science related attitude were identified by administrating the researcher’s self-developed science related attitude questionnaire which was adapted by consulting many others science related attitude scales. The study was conducted in three phase’s i-e in phase –I the cognitive learning styles of students were identified. In phase–II, the same students were consulted and science related attitude scale was administered to know the science related attitude of
students. In phase-III, the academic achievement of the undergraduate science students was obtained from the respective universities/DAI’s.

In this chapter, the collected data was analyzed to understand the cognitive learning styles and science related attitude of undergraduate science sample students of universities/DAIs of Islamabad. The data was analyzed manually in the first step, and then MS Excel and SPSS software were used for analysis. The data was tabulated and charts were developed for the presentation of data. Several statistical techniques such as Mean, Percentage, Standard Deviation, Chi Square, and t-test were used at 0.05 significance level.

This chapter has been divided into six (06) Parts.

Part-I Analyses of Cognitive Learning Styles

Section-I Analyses of Field-Dependent/Field-Independent Cognitive Learning Styles

a. Field-Dependent Cognitive Learning Style
b. Field-Independent Cognitive Learning Style

Section-II Analyses of Convergent/Divergent Cognitive Learning Styles

a. Convergent Cognitive Learning Style
b. Divergent Cognitive Learning Style

Part-II Analyses of Science related Attitude

Part –III Analyses of Academic Achievements

Part-IV Analysis of Science related Attitude with respect to Cognitive Learning Styles

Part-V Analyses of Academic Achievement with respect to Cognitive Learning Styles
Part-VI Relationships

a. Relationship of Cognitive Styles with Science related Attitude
b. Relationship of Cognitive Styles with Academic Achievement
c. Relationship of Academic Achievement with Science related Attitude

Each Part further consists of two or three subsections. Here is detail of each Part of this chapter.

PART-I
Analyses of Cognitive Learning Styles

In this section four types of cognitive learning styles were analyzed. These cognitive learning styles were Field-Dependent Cognitive Learning Style, Field-Independent Cognitive Learning Style, Convergent Cognitive Learning Style, and Divergent Cognitive Learning Style.

Section –I Analysis of Field-Dependent/Field-Independent Cognitive Learning Style

<table>
<thead>
<tr>
<th>Learning Style</th>
<th>HFT Score</th>
<th>No. of Students</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field-Dependent</td>
<td>0-3</td>
<td>310</td>
<td>25.37</td>
</tr>
<tr>
<td>Field Intermediate</td>
<td>3-10</td>
<td>691</td>
<td>56.55</td>
</tr>
<tr>
<td>Field-Independent</td>
<td>10-16</td>
<td>221</td>
<td>18.08</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1222</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4.1 shows the number of Field-Dependent / Field-Independent cognitive learning style of the whole sample.
The percentage of students identified as Field-Dependent was 25 percent whereas, more than two third of the sample students were identified as Field-Intermediate. However, 18 percent students were identified as Field-Independents.

Table 4.2 reflects the gender wise distribution of Field-Dependent/Field-Independent cognitive learning style of the whole sample. It shows that Field-Dependent is the preferred cognitive learning style whereas, Field-Independent is the preferred cognitive learning style of female. The same data has been presented in graphical form as follows.

![Figure 4.1 Bar graph of the Field-Dependent-Field-Independent the Whole Sample](image)

**Table 4.2**  
**Field –Dependent/Field -Independent Whole Sample With Respect To Gender**

<table>
<thead>
<tr>
<th>Learning Style</th>
<th>HFT Score</th>
<th>Gender</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field-Dependent</td>
<td>0-3</td>
<td>Male</td>
<td>209</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>31.52</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>18.07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>310</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>25.37</td>
</tr>
<tr>
<td>Field-Intermediate</td>
<td>3-10</td>
<td>Male</td>
<td>357</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>53.85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>334</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>59.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>691</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>56.53</td>
</tr>
<tr>
<td>Field-Independent</td>
<td>10-16</td>
<td>Male</td>
<td>97</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>16.63</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Female</td>
<td>124</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>22.18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>221</td>
</tr>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>18.08</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td>100</td>
<td>1222</td>
</tr>
</tbody>
</table>

Table 4.2 reflects the gender wise distribution of Field-Dependent/Field-Independent cognitive learning style of the whole sample. It shows that Field-Dependent is the preferred cognitive learning style whereas, Field-Independent is the preferred cognitive learning style of female. The same data has been presented in graphical form as follows.
Figure 4.2 Bar graph of the gender wise detail of the Field-Dependent-Field-Independent the Whole Sample

The Field-Dependent male students of the whole sample turned out to be 209. On the other hand 357 male students were identified as field Intermediate whereas, 97 male students were identified as Field-Independent. Similarly Field-Dependent female students of the whole sample were turned out to be 101 while Field-Intermediate was 334 and there were 124 Field-Independent female students. As per researches (Cao, 2006; Dabaghi and Goharimehr 2011; Zaman, 1996) in this study, we followed the same principle and considered only two ends i-e F.D and F.I as Field-Intermediate is not taken into consideration for analysis. In this way, more male undergraduate students were found Field-Dependent while more female undergraduate students were found comparatively Field-Independent.

In the tables, the hypotheses were tested by applying following Chi Square test formula:

$$\chi^2 = \frac{\sum(f_0 - f_e)^2}{f_e}$$

All the Hypotheses were tested on the (i) whole sample (ii) Gender and (iii) Strata. The data was tabulated and graphically presented. The initial data/ tabulation have been attached as Appendix -L.
a. Field-Dependent Cognitive Style

- Whole Sample Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{\text{Cal}}$</th>
<th>$\chi^2_{\text{Tab}}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male F.D</td>
<td>209 (67.4%)</td>
<td>37.62</td>
<td>3.84</td>
<td>0.000</td>
<td>$\chi^2_{\text{Cal}} &gt; \chi^2_{\text{Tab}}$</td>
</tr>
<tr>
<td>Female F.D</td>
<td>101 (32.6%)</td>
<td>37.62</td>
<td>3.84</td>
<td>0.000</td>
<td>$\chi^2_{\text{Cal}} &gt; \chi^2_{\text{Tab}}$</td>
</tr>
</tbody>
</table>

$\chi^2_{\text{Cal}}$ = Calculated Chi Square, $\chi^2_{\text{Tab}}$ = Tabulated Chi Square, $df = 1$

$p$ = Significance Value, LOS = Level of Significance

Table 4.3 reflects the Field-Dependent learning style of males and females. For more clarity, the same data has been presented in the following graph.

![Bar Graph of Field-Dependent Learning Style of Male and Female](image)

**Figure 4.3** Bar Graph of Field-Dependent Learning Style of Male and Female

**H01. There may be no significant difference between Field-Dependent cognitive learning style of male and female undergraduate science students**

The figure shows that 209 male were identified as F.D, while 101 female were identified as F.D. The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{\text{Cal}}$ was greater than $\chi^2_{\text{Tab}}$ value (37.626 > 3.84, $p=0.000$, $df=1$). It shows that, there is significant difference (at 0.05 significance level) between the preferred cognitive learning style (Field-Dependent) of male and female undergraduate science students. Majority of the male science students were found Field-Dependent therefore, the above hypothesis is rejected and alternate hypothesis is accepted i.e. there is significant difference between the preferred cognitive learning style (Field-Dependent) of male and female undergraduate science students.
**Strata Wise Analyses**

Table 4.4 *Field-Dependent Learning Style of Basic Science Strata With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{\text{cal}}$</th>
<th>$\chi^2_{\text{tab}}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male F.D of Basic Sciences Strata</td>
<td>56 (47.9%)</td>
<td>0.214</td>
<td>3.84</td>
<td>0.644</td>
<td>$\chi^2_{\text{cal}} &lt; \chi^2_{\text{tab}}$</td>
</tr>
<tr>
<td>Female F.D of Basic Sciences Strata</td>
<td>61 (52.1%)</td>
<td>$\chi^2_{\text{cal}}$ = Calculated Chi Square, $\chi^2_{\text{tab}}$ = Tabulated Chi Square, $df = 1$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$p$</td>
<td>= Significance Value, LOS = Level of Significance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.4 reflects the Field-Dependent learning style of males and females in the basic sciences strata. The same data has been presented in the following graph.

*Figure 4.4 Bar Graph of Field-Dependent Learning Style of Basic Sciences Strata With Respect To Gender*

$H_{01}$. There may be no significant difference between Field-Dependent cognitive learning style of male and female undergraduate science students

The figure shows that 56 male were identified as F.D, while 61 female were identified as F.D. The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{\text{cal}}$ was less than $\chi^2_{\text{tab}}$ value ($0.214 < 3.84$, $p = 0.644$, $df = 1$). It shows that in basic science strata, there is no significant difference (at 0.05 significance level) between the preferred cognitive learning style (Field-Dependent) of male and female undergraduate science students. Therefore, the above hypothesis is accepted.
Table 4.5 *Field-Dependent Learning Style of Computer Science Strata with respect to Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{Cal}$</th>
<th>$\chi^2_{Tab}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male F.D of Comp.Sci.Strata</td>
<td>40 (65.6%)</td>
<td>5.918</td>
<td>3.84</td>
<td>0.015 &amp; $\chi^2_{Cal} &gt; \chi^2_{Tab}$</td>
<td></td>
</tr>
<tr>
<td>Female F.D of Comp.Sci.Strata</td>
<td>21 (34.4%)</td>
<td></td>
<td></td>
<td></td>
<td>5.91 &gt; 3.84</td>
</tr>
</tbody>
</table>

$\chi^2_{Cal} = $ Calculated Chi Square, $\chi^2_{Tab} = $ Tabulated Chi Square, $df = 1$

$p = $ Significance Value, LOS = Level of Significance

Table 4.5 reflects the Field-Dependent learning style of males and females in the computer sciences strata. The same data has been presented in the following graph.

*Figure 4.5 Bar Graph Of Field-Dependent Learning Style Of Computer Science Strata With Respect To Gender*

**H$_{01}$ There may be no significant difference between Field-Dependent cognitive learning style of male and female undergraduate science students**

The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{Cal}$ was greater than $\chi^2_{Tab}$ value (5.918 $> 3.84$, $p=0.015$, $df=1$). It shows that in computer science strata, there is significant difference (at 0.05 significance level) between the preferred cognitive learning style (Field-Dependent) of male and female undergraduate science students. Majority of the male science students were found Field-Dependent therefore, the above hypothesis is rejected and alternate hypothesis is accepted i.e there is significant difference between the preferred cognitive style of F.D male and F.D female undergraduate science students.
Table 4.6: Field-Dependent Learning Style of Engineering Science Strata With Respect To Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{Cal}$</th>
<th>$\chi^2_{Tab}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male F.D of Engr. Sciences Strata</td>
<td>113 (85.6%)</td>
<td>66.939</td>
<td>3.84</td>
<td>0.000</td>
<td>$\chi^2_{Cal} &gt; \chi^2_{Tab}$</td>
</tr>
<tr>
<td>Female F.D of Engr. Sciences Strata</td>
<td>19 (14.4 %)</td>
<td>$\chi^2_{Cal}$ = Calculated Chi Square, $\chi^2_{Tab}$ = Tabulated Chi Square, df = 1, $p$ = Significance Value, LOS = Level of Significance</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.6 reflects the Field-Dependent learning style of males and females in the engineering sciences strata. The same data has been presented in the following graph.

Figure 4.6 Bar Graph of Field-Dependent Learning Style of Engineering Science Strata with respect to Gender

H01. There may be no significant difference between Field-Dependent cognitive learning style of male and female undergraduate science students

The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{Cal}$ was greater than $\chi^2_{Tab}$ value (66.939 > 3.84, p= 0.000, df=1 ). It shows that in the engineering science strata, there is significant difference (at 0.05 significance level) between the preferred cognitive learning style (Field-Dependent) of male and female undergraduate science students. As majority of the male science students were found Field-Dependent. Therefore, the above hypothesis is rejected and alternate hypothesis is accepted i-e there is significant difference between male F.D and female F.D cognitive learning style of undergraduate science students.
b. Field-Independent Cognitive Learning Style

- **Whole Sample Analysis**

  Table 4.7 *Field-Independent Learning Style of Whole Sample With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{\text{Cal}}$</th>
<th>$\chi^2_{\text{Tb}}$</th>
<th>$\chi^2_{\text{Cal}} &lt; \chi^2_{\text{Tb}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male F.I</td>
<td>97</td>
<td>3.29</td>
<td>3.84</td>
<td>0.069</td>
</tr>
<tr>
<td>Female F.I</td>
<td>124</td>
<td>3.29</td>
<td>3.84</td>
<td>0.069</td>
</tr>
</tbody>
</table>

- $\chi^2_{\text{Cal}} =$ Calculated Chi Square, $\chi^2_{\text{Tb}} =$ Tabulated Chi Square, df = 1
- $p =$ Significance Value, LOS = Level of Significance

Table 4.7 reflects the Field-Independent learning style of males and females. For more clarity, the same data has been presented in the following graph.

![Bar Graph of Field-Independent Learning Style of Male and Female](image)

*Figure 4.7 Bar Graph of Field-Independent Learning Style of Male and Female*

**$H_{02}$. There may be no significant difference between Field-Independent cognitive learning style of male and female undergraduate science students**

The figure shows that 97 male were identified as F.I, while 124 female were identified as F.I. The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{\text{Cal}}$ was less than $\chi^2_{\text{Tb}}$ value ($3.29 < 3.84, p = 0.069, \ df=1$). It shows that there is no significant difference between F.I learning styles w.r.t gender at 0.05 significance level. However, significant difference was found at 0.01 significance level therefore, the above hypothesis is rejected at 0.05 significance level and accepted at 0.01 significance level.
Strata Wise Analyses

Table 4.8  *Field-Independent Learning Style of Basic Science Strata With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{Cal}$</th>
<th>$\chi^2_{Tab}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male F.I of Basic Sciences Strata</td>
<td>11 (15.5%)</td>
<td>33.817</td>
<td>3.84</td>
<td>0.000</td>
<td>$\chi^2_{Cal} &gt; \chi^2_{Tab}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>33.81 &gt; 3.84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female F.I of Basic Sciences Strata</td>
<td>60 (84.5%)</td>
<td>$\chi^2_{Cal}$ = Calculated Chi Square, $\chi^2_{Tab}$ = Tabulated Chi Square, $df = 1$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$p$ = Significance Value, LOS = Level of Significance</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.8 reflects the Field-Independent learning style of males and females of basic science strata. The same data has been presented in the following graph.

*Figure 4.8* Bar Graph of Field-Independent Learning Style of Basic Sciences Strata with respect to Gender

**H02: There may be no significant difference between Field-Independent cognitive learning style of male and female undergraduate science students**

The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{Cal}$ was greater than $\chi^2_{Tab}$ value (33.817 > 3.84, $p = 0.000$, $df=1$). It shows that there is highly significant difference between F.I cognitive learning styles w.r.t gender (at 0.05 significance level) in the basic Science Strata. The preferred cognitive learning style of majority of female undergraduate science students was found Field-Independent, therefore, the above hypothesis is rejected and alternate hypothesis is accepted i-e there is significant difference between Field-Independent cognitive learning style of male and female undergraduate science students.
Table 4.9 *Field-Independent Learning Style of Computer Science Strata With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{Cal}$</th>
<th>$\chi^2_{Tab}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male F.I of Comp.Sci.Strata</td>
<td>31 (77.5%)</td>
<td>12.100</td>
<td>3.84</td>
<td>0.001</td>
<td>$\chi^2_{Cal} &gt; \chi^2_{Tab}$</td>
</tr>
<tr>
<td>Female F.I of Comp.Sci.Strata</td>
<td>9 (22.5%)</td>
<td>12.100 &gt; 3.84</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2_{Cal} = $ Calculated Chi Square, $\chi^2_{Tab} = $ Tabulated Chi Square, $df = 1$

$p = $ Significance Value, LOS = Level of Significance

Table 4.9 reflects the Field-Independent learning style of males and females of computer sciences strata. The same data has been presented in the following graph.

Figure 4.9 Bar Graph of Field-Independent Learning Style of Computer Science Strata with respect to Gender

**H$_{02}$. There may be no significant difference between Field-Independent cognitive learning style of male and female undergraduate science students**

The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{Cal}$ was greater than $\chi^2_{Tab}$ value (12.100 > 3.84, $p = 0.001$, $df=1$). It shows that there is significant difference between F.I cognitive learning styles w.r.t gender (at 0.05 significance level) in the Computer Science Strata. The preferred cognitive learning style of majority of male science students of Computer Science Strata was found Field-Independent. Hence, the above hypothesis is rejected and alternate hypothesis is accepted i.e there is significant difference between F.I cognitive learning style of male and female undergraduate science students.
Table 4.1 *Field-Independent Learning Style of Engineering Science Strata With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{\text{Cal}}$</th>
<th>$\chi^2_{\text{Tb}}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male F.I of Engr. Sciences Strata</td>
<td>55(50.0%)</td>
<td>0.000</td>
<td>3.84</td>
<td>1.000</td>
<td>$\chi^2_{\text{Cal}} &lt; \chi^2_{\text{Tb}}$</td>
</tr>
<tr>
<td>Female F.I of Engr. Sciences Strata</td>
<td>55(50.0%)</td>
<td>$\chi^2_{\text{Cal}}$</td>
<td>\text{Calculated Chi Square}</td>
<td>$\chi^2_{\text{Tb}}$</td>
<td>\text{Tabulated Chi Square}</td>
</tr>
</tbody>
</table>

$\chi^2_{\text{Cal}}$ = Calculated Chi Square, $\chi^2_{\text{Tb}}$ = Tabulated Chi Square, $df = 1$, $p$ = Significance Value, LOS = Level of Significance

Table 4.1 reflects the Field-Independent learning style of males and females of engineering science strata. The same data has been presented in the following graph.

![Bar Graph of Field-Independent Learning Style of Engineering Science Strata with respect to Gender](image)

*Figure 4.10* Bar Graph of Field-Independent Learning Style of Engineering Science Strata with respect to Gender

**H$_{02}$** There may be no significant difference between Field-Independent cognitive learning style of male and female undergraduate science students

The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{\text{Cal}}$, was less than $\chi^2_{\text{Tb}}$ value ($0.000 < 3.84$, $p = 1.000$, $df=1$). It shows that there is no significant difference between F.I cognitive learning styles w.r.t gender (at 0.05 significance level) in the Engineering Science Strata. The preferred cognitive learning style of male and female science students was found Field-Independent. Hence, the above hypothesis is rejected.
Section-II  Analysis of Convergent/ Divergent Cognitive Learning Style

In this section, the Convergent-Divergent cognitive styles of learning of the whole sample have been analyzed. The hypotheses were tested by applying Chi Square test.

Table 4.11 Overall Convergent –Divergent of the Whole Sample

<table>
<thead>
<tr>
<th>Learning Style</th>
<th>Marks</th>
<th>No. of Student</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convergent</td>
<td>0-29</td>
<td>200</td>
<td>16.3</td>
</tr>
<tr>
<td>Normal (All Rounder)</td>
<td>30-65</td>
<td>831</td>
<td>68.0</td>
</tr>
<tr>
<td>Divergent</td>
<td>66-130</td>
<td>191</td>
<td>15.63</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1222</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 4.11 shows the overall Convergent-Divergent of the whole sample. The same data has been presented in graphical form as follows.

*Figure 4.11* Bar graph of the overall Convergent-Divergent of the whole sample

The percentage of students identified as Convergent was 16.3 while 68 percentage of students were identified as normal (overall). There were 15.63 percentage of undergraduate science students were found as Divergent.
Table 4.12 *Gender wise Convergent –Divergent of the Whole Sample*

<table>
<thead>
<tr>
<th>Learning Style</th>
<th>CON-DIV Score</th>
<th>Gender</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>%</td>
<td>Female</td>
</tr>
<tr>
<td>Convergent</td>
<td>0-29</td>
<td>153</td>
<td>23.07</td>
</tr>
<tr>
<td>Normal (Overall)</td>
<td>30-65</td>
<td>451</td>
<td>68.02</td>
</tr>
<tr>
<td>Divergent</td>
<td>66-130</td>
<td>59</td>
<td>8.89</td>
</tr>
<tr>
<td>Total</td>
<td>663</td>
<td>100</td>
<td>559</td>
</tr>
</tbody>
</table>

Table 4.12 presents the gender wise Convergent- Divergent of the whole sample. The same analysis has been presented in graphical form as follows.

*Figure 4.12* Bar graph of the gender wise detail of the Convergent-Divergent of the Whole Sample

There were 153 male students categorized as Convergent and 47 female students were Convergent. There were 451 students categorized as normal or overall while 380 female students were in normal category. There were 59 male students in Divergent category, whereas, 132 female students were Divergent. Overall male found to be convergers, while female found to be Divergent. It shows that male students were more convergent while female students were comparatively more divergent.
As per researches (Alamolhodaei (2001); Bhatti, 2013; Den-Brok, Bergen & Brekelmans, 2004; Orlich, Harder, Callahan, Trevisan and Brown, 2009; Danili & Reid, 2006) in this study, we followed the same principle and considered only two ends i.e Convergent (CON) and Divergent (DIV) as Normal (overall) is not taken into consideration for analysis. The sample data has been presented in graphical form as follows.

In the tables, the hypotheses were tested by applying following Chi square test formula:

\[ \chi^2 = \sum \frac{(f_0 - f_e)^2}{f_e} \]

All the Hypotheses were tested on the (i) whole sample (ii) Gender and (iii) Strata. The data was tabulated and graphically represented. The initial data/tabulation have been attached as Appendix-M.
c. Convergent Cognitive Style

- Whole Sample Analysis

Table 4.13 Convergent Learning Style of Whole Sample With Respect To Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{cal}$</th>
<th>$\chi^2_{tab}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male CON</td>
<td>153 (76.5%)</td>
<td>56.180</td>
<td>3.84</td>
<td>0.000</td>
<td>$\chi^2_{cal} &gt; \chi^2_{tab}$ 56.180 &gt; 3.84</td>
</tr>
<tr>
<td>Female CON</td>
<td>47 (23.5%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2_{cal} = \text{Calculated Chi Square}, \quad \chi^2_{tab} = \text{Tabulated Chi Square}, \quad df = 1$

$p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance}$

Table 4.13 reflects the Convergent learning style of males and females. The same data has been presented in the following graph.

![Bar Graph of Convergent Learning Style of Male and Female](image)

**Figure 4.13** Bar Graph of Convergent Learning Style of Male and Female

**H03. There may be no significant difference between Convergent cognitive learning style of male and female undergraduate science students**

The figure 4.13 shows that 153 male were identified as Convergent, while 47 female were identified as Divergent. The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{cal}$ was greater than $\chi^2_{tab}$ value (56.180 > 3.84, $p=0.000$, $df=1$). It shows that there is significant difference between Convergent cognitive learning styles w.r.t gender at 0.05 significance level. The preferred cognitive learning style of majority of the male science students was found Convergent therefore, the above hypothesis rejected and alternate hypothesis is accepted i.e there is significant difference between male Convergent cognitive learning style of male and female science students.
• Strata Wise Analyses

Table 4.14  Convergent Learning Style of Basic Science Strata With Respect To Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{Cal}$</th>
<th>$\chi^2_{Tab}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male CON of Basic Sciences Strata</td>
<td>35 (53.0%)</td>
<td>0.242</td>
<td>3.84</td>
<td>0.622</td>
<td>$\chi^2_{Cal} &lt; \chi^2_{Tab}$</td>
</tr>
<tr>
<td>Female CON of Basic Sciences Strata</td>
<td>31 (47.0%)</td>
<td>$\chi^2_{Cal}$ = Calculated Chi Square, $\chi^2_{Tab}$ = Tabulated Chi Square, df = 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$p$ = Significance Value, LOS = Level of Significance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.14 reflects the Convergent learning style of males and females in the basic sciences strata. The same data has been presented in the following graph.

![Figure 4.14 Bar Graph of Convergent Learning Style of Male and Female of Basic Science Strata](image)

**Figure 4.14 Bar Graph of Convergent Learning Style of Male and Female of Basic Science Strata**

**H_03. There may be no significant difference between Convergent cognitive learning style of male and female undergraduate science students**

The figure shows that 35 male were identified as CON, while 31 female were identified as CON. The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{Cal}$ was less than $\chi^2_{Tab}$ value (0.242< 3.84, p= 0.622, df =1). It shows that there is no significant difference of CON learning styles w.r.t gender (at 0.05 significance level) in the basic Sciences Strata. Therefore, the above hypothesis is accepted.
Table 4.15 *Convergent Learning Style of Computer Science Strata With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{\text{cal}}$</th>
<th>$\chi^2_{\text{tab}}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male CON of Comp. Sciences Strata</td>
<td>40 (93.0%)</td>
<td>31.837</td>
<td>3.84</td>
<td>0.000</td>
<td>$\chi^2_{\text{cal}} &gt; \chi^2_{\text{tab}}$</td>
</tr>
<tr>
<td>Female CON of Comp.Sciences Strata</td>
<td>3 (7.0 %)</td>
<td>$\chi^2_{\text{cal}}$</td>
<td>Tabulated Chi Square, $df = 1$</td>
<td>$p = 0.000$, LOS = Level of Significance</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.15 reflects the convergent learning style of males and females in the computer sciences strata. The same data has been presented in the following graph.

*Figure 4.15* Bar Graph of Convergent Learning Style of Computer Science Strata With Respect to Gender

**H03.** There may be no significant difference between Convergent cognitive learning style of male and female undergraduate science students

The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{\text{cal}}$ was greater than $\chi^2_{\text{tab}}$ value (31.837 > 3.84, $p = 0.000$, $df=1$). It shows that there is significant difference of Convergent cognitive learning styles w.r.t gender (at 0.05 significance level) in the computer science strata. The preferred cognitive learning style of majority of the male science students was found convergent than female therefore, the above hypothesis is rejected and alternate hypothesis is accepted i.e there is significant difference between Convergent cognitive learning style of male and female undergraduate science students.
Table 4.16  *Convergent Learning Style of Engineering Science Strata With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{Cal}$</th>
<th>$\chi^2_{Tab}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male CON of Engr.Sci. Strata</td>
<td>78(85.7%)</td>
<td>46.429</td>
<td>3.84</td>
<td>0.000</td>
<td>$\chi^2_{Cal} &gt; \chi^2_{Tab}$</td>
</tr>
<tr>
<td>Female CON of Engr.Sci. Strata</td>
<td>13(14.3%)</td>
<td></td>
<td></td>
<td></td>
<td>46.429&gt;3.84</td>
</tr>
</tbody>
</table>

$\chi^2_{Cal}$ = Calculated Chi Square, $\chi^2_{Tab}$ = Tabulated Chi Square, $df = 1$

$p$ = Significance Value, LOS = Level of Significance

Table 4.16 reflects the Convergent learning style of males and females in the engineering sciences strata. The same data has been presented in the following graph.

*Figure 4.16 Bar Graph of Convergent Learning Style of Engineering Science Strata with respect to Gender*

$H_03.$ **There may be no significant difference between Convergent cognitive learning style of male and female undergraduate science students**

The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{Cal}$ was greater than $\chi^2_{Tab}$ value ($46.428 > 3.84$, $p= 0.000$, $df=1$). It shows that there is significant difference between Convergent cognitive learning styles of male and female (at 0.05 significance level) in the Engineering science strata. The preferred cognitive learning style of majority of the male science students was found convergent than female therefore, the above hypothesis is rejected and alternate hypothesis is accepted i-e there is significant difference between Convergent cognitive learning style of male and female undergraduate science students.
• Divergent Cognitive Learning Style

• Whole Sample Analysis

Table 4.17 Divergent Learning Style Of Whole Sample With Respect To Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{Cal}$</th>
<th>$\chi^2_{Tab}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male DIV</td>
<td>59</td>
<td>27.901</td>
<td>3.84</td>
<td>0.000</td>
<td>$\chi^2_{Cal} &gt; \chi^2_{Tab}$</td>
</tr>
<tr>
<td>Female DIV</td>
<td>132</td>
<td>27.901 &gt; 3.84</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2_{Cal}$ = Calculated Chi Square, $\chi^2_{Tab}$ = Tabulated Chi Square, df = 1

p = Significance Value, LOS = Level of Significance

Table 4.17 reflects the Divergent learning style of males and females. The same data has been presented in the following graph.

![Figure 4.17 Bar Graph of Divergent Learning Style of Male and Female](image)

H0. There may be no significant difference between Divergent cognitive learning style of male and female undergraduate science students

The figure 4.17 shows that 59 male were identified as Divergent, while 132 female were identified as Divergent. The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{Cal}$ was greater than $\chi^2_{Tab}$ value ($27.901 > 3.84$, $p = 0.000$, $df=1$). It shows that there is significant difference (at 0.05 significance level) between Divergent cognitive learning styles of male and female under graduate science students. The preferred cognitive learning style of majority of the female was found divergent hence, the above hypothesis is rejected and alternate hypothesis is accepted i.e there is significant difference between Divergent cognitive learning style of male and female undergraduate science students.
Strata Wise Analyses

Table 4.18  *Divergent Learning Style of Basic Science Strata With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{\text{Cal}}$</th>
<th>$\chi^2_{\text{Tab}}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male DIV of Basic Sciences Strata</td>
<td>12 (15.6%)</td>
<td>36.481</td>
<td>3.84</td>
<td>0.000</td>
<td>$\chi^2_{\text{Cal}} &gt; \chi^2_{\text{Tab}}$</td>
</tr>
<tr>
<td>Female DIV of Basic Sciences Strata</td>
<td>65( 84.4%)</td>
<td>36.481</td>
<td>&gt; 3.84</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2_{\text{Cal}}$ = Calculated Chi Square, $\chi^2_{\text{Tab}}$ = Tabulated Chi Square, df =1
p = Significance Value, LOS = Level of Significance

Table 4.18 reflects the Divergent learning style of males and females of basic science strata. The same data has been presented in the following graph.

![Bar Graph of Divergent Learning Style of Male and Female of Basic Sciences Strata](image)

*Figure 4.18* Bar Graph of Divergent Learning Style of Male and Female of Basic Sciences Strata

**H04. There may be no significant difference between Divergent cognitive learning style of male and female undergraduate science students**

The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{\text{Cal}}$ was greater than $\chi^2_{\text{Tab}}$ value (36.481 > 3.84, p = 0.000, df=1). It shows that there is highly significant difference between Divergent cognitive learning styles of male and female (at 0.05 significance level) in the basic Science Strata. The preferred cognitive learning style of majority of the female was found divergent hence, the above hypothesis is rejected and alternate hypothesis is accepted i-e there is significant difference between Divergent cognitive learning style of male and female undergraduate science students.
Table 4.19 *Divergent Learning Style of Computer Science Strata With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>(\chi^2_{\text{Cal}})</th>
<th>(\chi^2_{\text{Tab}})</th>
<th>(p)</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male DIV of Comp. Sciences Strata</td>
<td>16(43.27 %)</td>
<td>0.676</td>
<td>3.84</td>
<td>0.411</td>
<td>(\chi^2_{\text{Cal}} &lt; \chi^2_{\text{Tab}})</td>
</tr>
<tr>
<td>Female DIV of Comp. Sciences Strata</td>
<td>21(56.8 %)</td>
<td>0.676 &lt; 3.84</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(\chi^2_{\text{Cal}}\) = Calculated Chi Square, \(\chi^2_{\text{Tab}}\) = Tabulated Chi Square, \(df = 1\)

\(p\) = Significance Value, LOS = Level of Significance

Table 4.19 reflects the Divergent learning style of males and females of computer science strata. The same data has been presented in the following graph.

![Bar Graph of Divergent Learning Style of Male and Female of Computer Science Strata](image)

*Figure 4.19* Bar Graph of Divergent Learning Style of Male and Female of Computer Science Strata

**H04. There may be no significant difference between Divergent cognitive learning style of male and female undergraduate science students**

The \(\chi^2\) test was implied and it was found that the calculated value of \(\chi^2_{\text{Cal}}\) was less than \(\chi^2_{\text{Tab}}\) value (0.676 < 3.84, \(p = 0.411, df=1\)). It shows that there is no significant difference between Divergent cognitive learning styles of male and female undergraduate science students (at 0.05 significance level) in the Computer Science Strata. Therefore, the above hypothesis is accepted.
Table 4.20 Divergent Learning Style of Engineering Science Strata With Respect To Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>$\chi^2_{\text{Cal}}$</th>
<th>$\chi^2_{\text{Tab}}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male DIV of Engr. Sciences Strata</td>
<td>31(40.3%)</td>
<td>2.922</td>
<td>3.84</td>
<td>0.087</td>
<td>$\chi^2_{\text{Cal}} &lt; \chi^2_{\text{Tab}}$</td>
</tr>
<tr>
<td>Female DIV of Engr. Sciences Strata</td>
<td>46(59.7%)</td>
<td></td>
<td></td>
<td></td>
<td>2.922 &lt; 3.84</td>
</tr>
</tbody>
</table>

$\chi^2_{\text{Cal}}$ = Calculated Chi Square, $\chi^2_{\text{Tab}}$ = Tabulated Chi Square, df = 1

$p$ = Significance Value, LOS = Level of Significance

Table 4.20 reflects the divergent learning style of males and females of engineering science strata. The same data has been presented in the following graph.

![Bar Graph of Divergent Learning Style of Male and Female of Engineering Science Strata](image)

Figure 4.20 Bar Graph of Divergent Learning Style of Male and Female of Engineering Science Strata

H$_{04}$. There may be no significant difference between Divergent cognitive learning style of male and female undergraduate science students

The $\chi^2$ test was implied and it was found that the calculated value of $\chi^2_{\text{Cal}}$ was less than $\chi^2_{\text{Tab}}$ value (2.922 < 3.84, p =0.087, df=1). It shows that there is no significant difference of Divergent cognitive learning style of male and female undergraduate science students (at 0.05 significance level) in the Engineering Science Strata. The above hypothesis is rejected at 0.05 significance level but may be accepted at 0.01 significance level.
PART-II
Analysis of Mean Values of Science related Attitude Questionnaire Responded by Sample

In this part, the analysis of mean values of science related attitude questionnaire responded by undergraduate science students have been analyzed and presented. The sample consisted of male and female students of undergraduate science students. In this part, the following analyses have been presented:

- Whole sample analysis
- Strata wise analysis

The mean values of science related attitude questionnaire responses have been analyzed. The hypotheses were tested by applying the following “t test”.

\[
t = \frac{\overline{x}_1 - \overline{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}
\]

Where

where \(\overline{x}_1\) = mean of sample 1
\(\overline{x}_2\) = mean of sample 2
\(n_1\) = number of subjects in sample 1
\(n_2\) = number of subjects in sample 2
\(s_1^2\) = variance of sample 1 = \(\frac{\Sigma(x_1 - \overline{x}_1)^2}{n_1}\)
\(s_2^2\) = variance of sample 2 = \(\frac{\Sigma(x_2 - \overline{x}_2)^2}{n_2}\)

The data was tabulated and graphically presented.
Whole Sample Analysis

Table 4.21 *Science related Attitude of Whole Sample With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>(t_{\text{Cal}})</th>
<th>(t_{\text{Tab}})</th>
<th>(p)</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of Male</td>
<td>663</td>
<td>3.627</td>
<td>0.51154</td>
<td>0.003</td>
<td>1.962</td>
<td>0.998</td>
<td>(t_{\text{Cal}} &lt; t_{\text{Tab}})</td>
</tr>
<tr>
<td>Science related attitude of Female</td>
<td>559</td>
<td>3.627</td>
<td>0.49228</td>
<td>0.003</td>
<td>1.962</td>
<td>0.998</td>
<td>(0.003 &lt; 1.962)</td>
</tr>
</tbody>
</table>

\(t_{\text{Cal}} = \) Calculated t-Value, \(t_{\text{Tab}} = \) Tabulated t-Value, \(df = 1220\), \(p = \) Significance Value, \(LOS = \) Level of Significance

Table 4.21 reflects the mean values of science related attitude of whole sample. For more clarity, the same data has been presented in the following graph.

*Figure 4.21* Mean Plot of Science related attitude of Whole Sample With Respect to Gender

\(H_05: \text{There may be no significant difference between science related attitude of male and female undergraduate science students}\)

The t-test was implied and it was found that the calculated value of \(t_{\text{Cal}}\) was less than \(t_{\text{Tab}}\) (0.003 < 1.962, \(p = 0.998, df=1220\)). It shows that in the whole sample, there is no significant difference (at 0.05 significance level) between mean values of responses regarding science related attitude of male and female undergraduate science students. Hence, the above hypothesis is accepted.
Strata Wise Analyses

Table 4.22 Science related Attitude of Basic Sciences Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{cal}} )</th>
<th>( t_{\text{tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of Male of Basic Sciences Strata</td>
<td>158</td>
<td>3.6251</td>
<td>0.5150</td>
<td>-1.220</td>
<td>1.984</td>
<td>0.223</td>
<td>( t_{\text{cal}} &lt; t_{\text{tab}} )</td>
</tr>
<tr>
<td>Science related attitude of Female of Basic Sciences Strata</td>
<td>320</td>
<td>3.6831</td>
<td>0.4749</td>
<td>( 1.220 &lt; 1.984 )</td>
<td>( p = 0.223 ) ( df = 476 )</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( t_{\text{cal}} = \) Calculated t-Value, \( t_{\text{tab}} = \) Tabulated t-Value, \( df = 476 \)
\( p = \) Significance Value, \( LOS = \) Level of Significance

Table 4.22 reflects the mean values of science related attitude of basic science strata. For more clarity, the same data has been presented in the following graph.

**Figure 4.22** Mean Plot of Science related attitude of Basic Science Strata

**H05. There may be no significant difference between science related attitude of male and female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{\text{cal}} \) was less than \( t_{\text{tab}} \) (1.220 < 1.984, \( p = 0.223 \), \( df = 476 \)). There was slight difference between mean values of science related attitude responses of male and female undergraduate science students of basic science strata. The mean value of science related attitude responses of female was more than mean value of science related attitude responses of male. However, no significant difference (at 0.05 significance level) was found regarding mean values of science related attitude questionnaire responded by male and female of basic Science Strata. Hence, the above hypothesis is accepted.
Table 4.23 *Science related Attitude of Computer Sciences Strata*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( p )</th>
<th>At 0.05</th>
<th>LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of Male of Comp. Science Strata</td>
<td>163</td>
<td>3.6256</td>
<td>0.4837</td>
<td>3.176</td>
<td>1.984</td>
<td>0.002</td>
<td>( t_{\text{Cal}} &gt; t_{\text{Tab}} )</td>
<td>3.176 &gt; 1.984</td>
</tr>
<tr>
<td>Science related attitude of Female of Comp. Science Strata</td>
<td>82</td>
<td>3.4224</td>
<td>0.4490</td>
<td>( t_{\text{Cal}} = ) Calculated t-Value, ( t_{\text{Tab}} = ) Tabulated t-Value, ( df = 243 )</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( p = ) Significance Value, LOS = Level of Significance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.23 reflects the mean values of science related attitude of computer science strata. For more clarity, the same data has been presented in the following graph.

*Figure 4.23 Mean Plot of Science related attitude of Computer Science Strata*

**Hₐ. There may be no significant difference between science related attitude of male and female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was greater than \( t_{\text{Tab}} \) (3.176 > 1.984, \( p = 0.002, df=243 \)). It shows that there is significant difference (at 0.05 significance level) between mean values of science related science related attitude responses of male and female undergraduate science students of Computer Science Strata. The mean value of science related attitude responses of male was more than mean value of science related attitude responses of female undergraduate science students. Hence, the above hypothesis is rejected and alternate hypothesis is accepted i.e there is significant difference between science related attitude of male and female undergraduate science students.
Table 4.24 *Science related Attitude of Engineering Sciences Strata*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{cal}$</th>
<th>$t_{tab}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of Male of Engineering Sciences Strata</td>
<td>342</td>
<td>3.6292</td>
<td>0.52408</td>
<td>0.173</td>
<td>1.984</td>
<td>0.863</td>
<td></td>
</tr>
<tr>
<td>Science related attitude of Female Engineering Sciences Strata</td>
<td>157</td>
<td>3.6205</td>
<td>0.52196</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$t_{cal} = \text{Calculated } t\text{-Value}, \quad t_{tab} = \text{Tabulated } t\text{-Value}, \quad df = 497 \quad p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance}$

Table 4.24 reflects the mean values of science related attitude of Engineering Science Strata. For more clarity, the same data has been presented in the following graph.

*Figure 4.24* Mean Plot of Science related attitude of Engineering Science Strata

**H_{05}. There may be no significant difference between science related attitude of male and female undergraduate science students**

The t-test was implied and it was found that the calculated value of $t_{cal}$ was less than $t_{tab} \ (0.173 < 1.984, \ p = 0.863, \ df=497)$. Although there is slight difference of mean value of science related attitude responses of male and female undergraduates of Engineering Science Strata. The mean value of science related attitude responses of male was more than mean value of science related attitude responses of female but it is not significant difference (at 0.05 significance level). Hence, the above hypothesis is accepted.
PART-III
Analysis of Mean values of Academic Achievement of Sample

In this part, the analysis of mean value of academic achievement of undergraduate science students have been analyzed and presented. The sample consisted of male and female students of undergraduate science students.

In this part, the following analyses have been presented:

- Whole sample analysis
- Strata wise analysis
- Programme wise analysis

The mean values of academic achievements of whole sample have been analyzed. The hypotheses were tested by applying following “t test”.

\[ t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \]

Where

- \( \bar{x}_1 \) = mean of sample 1
- \( \bar{x}_2 \) = mean of sample 2
- \( n_1 \) = number of subjects in sample 1
- \( n_2 \) = number of subjects in sample 2
- \( s_1^2 \) = variance of sample 1 = \( \frac{\Sigma(x_1 - \bar{x}_1)^2}{n_1} \)
- \( s_2^2 \) = variance of sample 2 = \( \frac{\Sigma(x_2 - \bar{x}_2)^2}{n_2} \)

The initial tabulation data is attached as appendix-N. The Inferential data was tabulated and graphically presented.
Whole Sample Analysis

Table 4.25 Academic Achievement of Whole Sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{cal}$</th>
<th>$t_{tab}$</th>
<th>p</th>
<th>At 0.05LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of Male</td>
<td>663</td>
<td>2.7133</td>
<td>0.7330</td>
<td>-5.969</td>
<td>1.962</td>
<td>0.000</td>
<td>$t_{cal} &gt; t_{tab}$</td>
</tr>
<tr>
<td>Academic Achievement of Female</td>
<td>559</td>
<td>2.9509</td>
<td>0.6422</td>
<td>5.969</td>
<td>1.962</td>
<td></td>
<td>$5.969 &gt; 1.962$</td>
</tr>
</tbody>
</table>

$t_{cal} =$ Calculated t-Value, $t_{tab} =$ Tabulated t-Value, $df = 1220$

$p = $ Significance Value, LOS = Level of Significance

Table 4.25 reflects the mean values of academic achievement of whole sample. For more clarity, the same data has been presented in the following graph.

Figure 4.25 Mean Plot of Academic Achievement of Whole Sample With Respect to Gender

$H_{06}$. There may be no significant difference between academic achievement of male and female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{cal}$ was greater than $t_{tab}$ ($5.969 > 1.962$, $p=0.000$, $df=1220$). It shows that in the whole sample, there is significant difference (at 0.05 significance level) between mean value of academic achievement of male and female undergraduate science students. Female undergraduate science students obtained higher academic achievement than male. Hence, the above hypothesis is rejected and the alternate hypothesis is accepted i.e. there is significant difference between academic achievement of male and female undergraduate science students.
• Strata Wise Analyses

Table 4.26 Academic Achievement of Basic Sciences Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of Male of Basic Science Strata</td>
<td>158</td>
<td>2.808</td>
<td>0.9286</td>
<td>-1.803</td>
<td>1.984</td>
<td>0.072</td>
<td>( t_{\text{Cal}} &lt; t_{\text{Tab}} )</td>
</tr>
<tr>
<td>Academic Achievement of Female of Basic Science Strata</td>
<td>320</td>
<td>2.942</td>
<td>0.6748</td>
<td>1.803</td>
<td>1.984</td>
<td>0.072</td>
<td>( t_{\text{Cal}} &gt; t_{\text{Tab}} )</td>
</tr>
</tbody>
</table>

\( t_{\text{Cal}} = \) Calculated \( t \)-Value, \( t_{\text{Tab}} = \) Tabulated \( t \)-Value, \( df = 476 \)

\( p = \) Significance Value, \( \text{LOS} = \) Level of Significance

Table 4.26 reflects the mean values of Academic Achievement of basic Science Strata. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Academic Achievement of Basic Science Strata](image)

Figure 4.26 Mean Plot of Academic Achievement of Basic Science Strata

H\(_0\)\(_6\). There may be no significant difference between academic achievement of male and female undergraduate science students

The \( t \)-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was less than \( t_{\text{Tab}} \) \((1.803 < 1.984, \ p=0.072, \ df=476)\). Although there is slight difference between mean value of academic achievement of male and female undergraduate science students of basic Science Strata. Female undergraduate science students obtained higher academic achievement than male undergraduate science students. But this difference of mean values of academic achievement is not significant (at 0.05 significance level). Hence, the above hypothesis is accepted.
Table 4.27 Academic Achievement of Computer Sciences Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( p )</th>
<th>At 0.05</th>
<th>LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of Male of Comp. Science Strata</td>
<td>163</td>
<td>2.6443</td>
<td>0.6001</td>
<td>-2.454</td>
<td>1.984</td>
<td>0.015</td>
<td>( t_{\text{Cal}} &gt; t_{\text{Tab}} )</td>
<td></td>
</tr>
<tr>
<td>Academic Achievement of Female of Comp. Science Strata</td>
<td>82</td>
<td>2.8452</td>
<td>0.6143</td>
<td>( = )</td>
<td>( \neq )</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( t_{\text{Cal}} = \) Calculated t-Value, \( t_{\text{Tab}} = \) Tabulated t-Value, \( df = 243 \), \( p \) = Significance Value, LOS = Level of Significance

Table 4.27 reflects the mean values of Academic Achievement of Computer Science Strata. For more clarity, the same data has been presented in the following graph.

![Graph showing mean academic achievement by gender](image)

**Figure 4.27** Mean Plot of Academic Achievement of Computer Science Strata

**H_{06}.** There may be no significant difference between academic achievement of male and female undergraduate science students

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was greater than \( t_{\text{Tab}} \) (2.454 > 1.984, \( p = 0.015 \), \( df = 243 \)). There is significant difference (at 0.05 significance level) of mean values of Academic Achievement of male and female of Computer Science Strata. Female undergraduate science students obtained higher academic achievement than male. Hence, the above hypothesis is rejected and alternate hypothesis that there is significant difference between academic achievement of male and female undergraduate science students.
Table 4.28 *Academic Achievement of Engineering Sciences Strata*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( p )</th>
<th>At 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of Male of Engr. Science Strata</td>
<td>342</td>
<td>2.702</td>
<td>0.684</td>
<td>-5.083</td>
<td>1.984</td>
<td>0.000</td>
<td>5.083 &gt; 1.984</td>
</tr>
<tr>
<td>Academic Achievement of Female of Engr. Science Strata</td>
<td>157</td>
<td>3.022</td>
<td>0.580</td>
<td>5.083</td>
<td>&gt; 1.984</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( t_{\text{Cal}} \) = Calculated t-Value, \( t_{\text{Tab}} \) = Tabulated t-Value, \( df = 497 \)

\( p \) = Significance Value, LOS = Level of Significance

Table 4.28 reflects the mean values of Academic Achievement of Engineering Science Strata. For more clarity, the same data has been presented in the following graph.

*Figure 4.28 Mean Plot of Academic Achievement of Engineering Science Strata*

**H06. There may be no significant difference between academic achievement of male and female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was greater than \( t_{\text{Tab}} \) (5.083 > 1.984, \( p = 0.000 \), \( df = 497 \)). It shows that there is significant difference (at 0.05 significance level) between mean values of Academic Achievement of male and female undergraduate science students of Engineering Science Strata. Female undergraduate science students have higher academic achievement than male. Hence, the above hypothesis is rejected.
PART-IV

Analysis of Science related Attitude between male and female with respect to Cognitive Styles of Learning

In this part, the analysis of mean value of science related attitude of undergraduate science students with respect to Cognitive Styles of Learning have been analyzed and presented. The sample consisted of male and female students of undergraduate science students. This section is divided into following sections:

Section-I Analysis of Science related attitude of male and female with respect to Field-Dependent/Field-Independent Cognitive Learning Style

a. Science related attitude of Field-Dependent male and Field-Dependent female

b. Science related attitude of Field-Independent male and Field-Independent female

c. Science related attitude of Field-Dependent male and Field-Independent male

d. Science related attitude of Field-Dependent female and Field-Independent female

Section-II Analysis of Science related attitude of male and female with respect to Convergent/Divergent Cognitive Learning Style

a. Science related attitude of Convergent male and Convergent female

b. Science related attitude of Divergent male and Divergent female

c. Science related attitude of Convergent male and Divergent male

d. Science related attitude of Convergent female and Divergent female
In this Part, the mean values of science related attitude of whole sample with respect to Cognitive styles of Learning have been analyzed. The hypotheses were tested by applying following “t test”.

\[ t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \]

Where

where \( \bar{x}_1 \) = mean of sample 1  
\( \bar{x}_2 \) = mean of sample 2  
\( n_1 \) = number of subjects in sample 1  
\( n_2 \) = number of subjects in sample 2  
\( s_1^2 \) = variance of sample 1 = \( \frac{\sum(x_1 - \bar{x}_1)^2}{n_1} \)  
\( s_2^2 \) = variance of sample 2 = \( \frac{\sum(x_2 - \bar{x}_2)^2}{n_2} \)

The data was tabulated and graphically presented.

Section-I

Analysis of Science related Attitude with respect to Field-Dependent/Field-Independent Cognitive Learning Style

This section deals with the analysis of Science related attitude with respect to Field-Dependent/Field-Independent Cognitive Learning Style.
Table 4.29  *Science related Attitude of Field-Dependent and Field-Independent of Whole Sample*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( P )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude</td>
<td>310</td>
<td>3.544</td>
<td>0.5163</td>
<td>-4.748</td>
<td>1.984</td>
<td>0.000</td>
<td>( t_{\text{Cal}} &gt; t_{\text{Tab}} )</td>
</tr>
<tr>
<td>of F.D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.748 &gt; 1.984</td>
</tr>
<tr>
<td>Science related</td>
<td>221</td>
<td>3.752</td>
<td>0.4676</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>attitude of F.I</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( t_{\text{Cal}} = )</td>
<td></td>
<td></td>
<td></td>
<td>Calculated t-Value</td>
<td>Tabulated t-Value</td>
<td>df = 529</td>
<td></td>
</tr>
<tr>
<td>( t_{\text{Tab}} = )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( p = ) Significance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value, ( \text{LOS} = )</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of Significance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.29 reflects the mean values of Science related attitude of Field-Dependent and Field-Independent of whole sample. For more clarity, the same data has been presented in the following graph.

*Figure 4.29 Mean Plot of Science related Attitude of Field–Dependent/ Field – Independent of Whole Sample*

\( H_0 \): There may be no significant difference between science related attitude of undergraduate science students having Field Dependent and Field Independent cognitive learning styles

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was greater than \( t_{\text{Tab}} \) (4.748 > 1.984, \( p = 0.000 \), df=529). It shows that there is highly significant difference (at 0.05 significance level) between science mean values of science related attitude responses of Field-Dependents and Field-Independents of whole sample. The mean value of science related attitude responses of Field-Independents was higher than Field-Dependents. Hence, the above hypothesis is rejected.
a. Science related Attitude of male and female with respect to Field – Dependent Cognitive Learning Style

- Whole Sample

Table 4.30 Science related attitude of Field-Dependent With Respect To Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{\text{Cal}}$</th>
<th>$t_{\text{Tab}}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Male</td>
<td>209</td>
<td>3.5798</td>
<td>0.54594</td>
<td>1.731</td>
<td>1.984</td>
<td>0.084</td>
<td>$t_{\text{Cal}} &lt; t_{\text{Tab}}$</td>
</tr>
<tr>
<td>Science related attitude of F.D Female</td>
<td>101</td>
<td>3.4719</td>
<td>0.44253</td>
<td></td>
<td></td>
<td></td>
<td>1.731&lt;1.984</td>
</tr>
</tbody>
</table>

$\text{t}_{\text{Cal}} =$ Calculated $t$-Value, \hspace{1cm} $\text{t}_{\text{Tab}} =$ Tabulated $t$-Value, \hspace{1cm} $df =$308

$p =$ Significance Value, \hspace{1cm} LOS =$ Level of Significance

Table 4.30 reflects the mean values of Science related attitude of Field- Dependents male and female of whole sample. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Science related Attitude](image)

**Figure 4.30** Mean Plot of Science related Attitude of Field –Dependents of Whole Sample with respect to Gender

H$_{07a}$. There may be no significant difference between science related attitude of F.D male and F.D female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{\text{Cal}}$ was less than $t_{\text{Tab}}$ (1.731< 1.984, \hspace{1cm} p= 0.084, \hspace{1cm} $df=$308). Although the mean value of science related attitude responses of male undergraduate science students was comparatively higher than mean value of science related attitude responses of female However, there the difference is not significant (at 0.05 significance level). Hence, the above hypothesis is accepted.
- **Strata wise Analysis**

Table 4.31 *Science related attitude of Field-Dependent of Basic Science Strata With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t(_{cal})</th>
<th>t(_{tab})</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Male of Basic Sci. Strata</td>
<td>56</td>
<td>3.617</td>
<td>0.5043</td>
<td>0.832</td>
<td>1.984</td>
<td>0.407</td>
<td>0.832&lt;1.984</td>
</tr>
<tr>
<td>Science related attitude of F.D Female of Basic Sci. Strata</td>
<td>61</td>
<td>3.542</td>
<td>0.4706</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[t_{cal} = \text{Calculated t-Value}, \quad t_{tab} = \text{Tabulated t-Value}, \quad df = 115\]

\[p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance}\]

Table 4.31 reflects the mean values of Science related attitude of male and female Field-Dependents of basic science strata. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Science related Attitude of Field–Dependents of Basic Science Strata](image)

*Figure 4.31* Mean Plot of Science related Attitude of Field–Dependents of Basic Science Strata

**H07a. There may be no significant difference between science related attitude of F.D male and F.D female undergraduate science students**

The t-test was implied and it was found that the calculated value of \(t_{cal}\) was less than \(t_{tab}\) (0.832 < 1.984, \(p = 0.407, \ df = 115\)). Although there was difference between mean values of science related attitude of male and female Field-Dependent undergraduate science students. The mean value of science related attitude responses of male undergraduate science students was higher than mean value of science related attitude responses of female undergraduate science students. However, the difference was not significant (at 0.05 significance level) in the basic science strata. Hence, the above hypothesis is accepted.
Table 4.32 *Science related Attitude of Field-Dependent of Computer Science Strata With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t&lt;sub&gt;cal&lt;/sub&gt;</th>
<th>t&lt;sub&gt;tab&lt;/sub&gt;</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Male of Comp. Science Strata</td>
<td>40</td>
<td>3.4805</td>
<td>0.5158</td>
<td>1.571</td>
<td>2.000</td>
<td>0.122</td>
<td>t&lt;sub&gt;cal&lt;/sub&gt; &lt; t&lt;sub&gt;tab&lt;/sub&gt;</td>
</tr>
<tr>
<td>Science related attitude of F.D Female of Comp. Science Strata</td>
<td>21</td>
<td>3.2789</td>
<td>0.3878</td>
<td>1.571</td>
<td>2.000</td>
<td>0.122</td>
<td>t&lt;sub&gt;cal&lt;/sub&gt; &lt; t&lt;sub&gt;tab&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

$t_{cal} = \text{Calculated t-Value}, \quad t_{tab} = \text{Tabulated t-Value}, \quad df = 59$

$p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance}$

Table 4.32 reflects the mean values of Science related attitude of male and female Field-Dependent of computer science strata. For more clarity, the same data has been presented in the following graph.

*Figure 4.32 Mean Plot of Science related Attitude of Field-Dependents of Computer Science Strata with respect to Gender*

**H<sub>0</sub>a. There may be no significant difference between science related attitude of F.D male and F.D female undergraduate science students**

The t-test was implied and it was found that the calculated value of $t_{cal}$ was less than $t_{eb}$ ($1.571 < 2.000$, $p = 0.122$, $df=59$). Although there was difference between mean values of science related attitude responses of Field-Dependent male and female undergraduate science students. Male undergraduate science students have comparatively higher mean values of science related attitude than female. However, there is no significant difference (0.05 significant level) in computer science strata. Hence, the above hypothesis is accepted.
Table 4.33 Science related Attitude of Field-Dependent of Engineering Science Strata with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{\text{Cal}}$</th>
<th>$t_{\text{Tab}}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Male of Engr. Science Strata</td>
<td>113</td>
<td>3.5964</td>
<td>0.5757</td>
<td>1.010</td>
<td>1.984</td>
<td>0.315</td>
<td>$t_{\text{Cal}} &lt; t_{\text{Tab}}$</td>
</tr>
<tr>
<td>Science related attitude of F.D Female of Engr. Science Strata</td>
<td>19</td>
<td>3.4587</td>
<td>0.3490</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

$t_{\text{Cal}}$ = Calculated t-Value, $t_{\text{Tab}}$ = Tabulated t-Value, $df$ = 130
$p$ = Significance Value, LOS = Level of Significance

Table 4.33 reflects the mean values of Science related attitude of male and female Field-Dependents of engineering science strata. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Science related Attitude of Field-Dependents of Engineering Science Strata with respect to Gender](image)

Figure 4.33 Mean Plot of Science related Attitude of Field-Dependents of Engineering Science Strata with respect to Gender

**H07a. There may be no significant difference between science related attitude of F.D male and F.D female undergraduate science students**

The $t$-test was implied and it was found that the calculated value of $t_{\text{Cal}}$ was less than $t_{\text{Tab}}$ $(1.010 < 1.984, p=0.315, df=130)$. Although there was difference between mean values of science related attitude of Field-Dependent male and female. Male have comparatively more science related attitude than female. However, there is no significant difference (0.05 significant level) between mean values of Science related attitude responses of male Field-Dependents and female Field-Dependents of engineering science strata. Hence, the above hypothesis is accepted.
b. Science related Attitude of Male And Female With Respect To Field-Independent Cognitive Learning Style

- Whole Sample

Table 4.34 Science related Attitude of Field-Independent with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{\text{cal}}$</th>
<th>$t_{\text{tab}}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.I Male</td>
<td>97</td>
<td>3.7647</td>
<td>0.46598</td>
<td></td>
<td></td>
<td>0.348</td>
<td>&lt; 1.984</td>
</tr>
<tr>
<td>Science related attitude of F.I Female</td>
<td>124</td>
<td>3.7426</td>
<td>0.47068</td>
<td></td>
<td></td>
<td>0.728</td>
<td></td>
</tr>
</tbody>
</table>

$t_{\text{cal}} = \text{Calculated } t\text{-Value}$, $t_{\text{tab}} = \text{Tabulated } t\text{-Value}$, $df = 219$,

$p = \text{Significance Value}$, $LOS = \text{Level of Significance}$

Table 4.34 reflects the mean values of Science related attitude of male and female Field-Independents of whole sample. For more clarity, the same data has been presented in the following graph.

Figure 4.34 Mean Plot of Science related Attitude of Field –Independents with respect to Gender

$H_{07b}$. There may be no significant difference between science related attitude of F.I male and F.I female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{\text{cal}}$ was less than $t_{\text{tab}}$ ($0.348 < 1.984$, $p = 0.728$, $df = 219$). It shows that there is no significant difference (at 0.05 significance level) between mean values of science related attitude responses of Field-Independents male and female undergraduate science students. Hence, the above hypothesis is accepted.
Strata wise Analysis

Table 4.35 Science related Attitude of Field-Independent of Basic Science Strata with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{\text{cal}}$</th>
<th>$t_{\text{tab}}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.I Male of Basic Sciences Strata</td>
<td>11</td>
<td>3.8897</td>
<td>0.4316</td>
<td>0.606</td>
<td>1.990</td>
<td>0.547</td>
<td>$t_{\text{cal}} &lt; t_{\text{tab}}$</td>
</tr>
<tr>
<td>Science related attitude of F.I Female of Basic Sciences Strata</td>
<td>60</td>
<td>3.8052</td>
<td>0.4242</td>
<td></td>
<td></td>
<td></td>
<td>0.606&lt;1.990</td>
</tr>
</tbody>
</table>

$t_{\text{cal}}$ = Calculated t-Value, $t_{\text{tab}}$ = Tabulated t-Value, $df = 69$
$p$ = Significance Value, LOS = Level of Significance

Table 4.35 reflects the mean values of Science related attitude of male and female Field-Independents of basic science strata. For more clarity, the same data has been presented in the following graph.

Figure 4.35 Mean Plot of Science related Attitude of Field-Independents of Basic Science Strata with respect to Gender

H$_{07b}$. There may be no significant difference between science related attitude of F.I male and F.I female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{\text{cal}}$ was less than $t_{\text{tab}}$ (0.606 < 1.990, $p = 0.547$, $df=69$). It shows that there is no significant difference (at 0.05 significance level) between mean values of science related attitude responses of Field-Independents male and female undergraduate science students of basic science strata. Hence, the above hypothesis is accepted.
Table 4.36 *Science related Attitude of Field-Independent of Computer Science Strata with respect to Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.I Male of Comp. Sci.Strata</td>
<td>31</td>
<td>3.7689</td>
<td>0.54172</td>
<td>1.201</td>
<td>2.040</td>
<td>0.237</td>
<td>&lt;</td>
</tr>
<tr>
<td>Science related attitude of F.I Female of Comp.Sci.Strata</td>
<td>9</td>
<td>3.5202</td>
<td>0.56652</td>
<td>1.201&lt;2.040</td>
<td>0.237</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ t_{\text{Cal}} = \text{Calculated t-Value} , \quad t_{\text{Tab}} = \text{Tabulated t-Value} , \quad df = 38^- \]
\[ p = \text{Significance Value} , \quad \text{LOS} = \text{Level of Significance} \]

Table 4.36 reflects the mean values of Science related attitude of male and female Field-Independents of computer science strata. For more clarity, the same data has been presented in the following graph.

*Figure 4.36* Mean Plot of Science related Attitude of Field –Independents of Computer Science Strata with respect to Gender

\( H_{07b} \). There may be no significant difference between science related attitude of F.I male and F.I female undergraduate science students

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was less than \( t_{\text{Tab}} \) (1.201 < 2.040, \( p=0.237 , \quad df=38 \)). Although male possess comparatively more science related attitude than female. However, there is no significant difference (0.05 significant level) between mean values of science related attitude responses of male Field-Independent and female Field-Independent undergraduate science students of computer Science Strata. Hence, the above hypothesis is accepted.
Table 4.37 Science related Attitude of Field-Independent of Engineering Science Strata with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{Cal} )</th>
<th>( t_{Tab} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.I Male of Engr.Sci. Strata</td>
<td>55</td>
<td>3.7373</td>
<td>0.42956</td>
<td>0.301</td>
<td>1.984</td>
<td>0.764</td>
<td>( t_{Cal} &lt; t_{Tab} )</td>
</tr>
<tr>
<td>Science related attitude of F.I Female of Engr.Sci.Strata</td>
<td>55</td>
<td>3.7107</td>
<td>0.49680</td>
<td>0.301</td>
<td>1.984</td>
<td>0.764</td>
<td>( 0.301&lt;1.984 )</td>
</tr>
</tbody>
</table>

\( t_{Cal} = \) Calculated t-Value  \( t_{Tab} = \) Tabulated t-Value  \( df = 108 \)

\( p = \) Significance Value  \( LOS = \) Level of Significance

Table 4.37 reflects the mean values of Science related attitude of male and female Field-Independents of engineering science strata. For more clarity, the same data has been presented in the following graph.

![Graph showing mean plot of science related attitude of F.I male and F.I female undergraduate science students](image)

**Figure 4.37** Mean Plot of Science related Attitude of Field –Independents of Engineering Science Strata with respect to Gender

**H07b. There may be no significant difference between science related attitude of F.I male and F.I female undergraduate science students**

The \( t \)-test was implied and it was found that the calculated value of \( t_{Cal} \) was less than \( t_{Tab} \) (0.301 < 1.984, \( p = 0.764 \), \( df=108 \)). It shows that there is no significant difference (at 0.05 significance level) between mean values of science related attitude responses of Field-Independents male and female undergraduate science students of engineering science strata. Hence, the above hypothesis is accepted.
c. **Science related Attitude between Field-Dependent male and Field-Independent male**

- **Whole Sample**

Table 4.38 *Science related Attitude of Field-Dependent Male and Field-Independent Male*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t&lt;sub&gt;Cal&lt;/sub&gt;</th>
<th>t&lt;sub&gt;Tab&lt;/sub&gt;</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Male</td>
<td>209</td>
<td>3.5798</td>
<td>0.54594</td>
<td>-2.882</td>
<td>1.984</td>
<td>0.004</td>
<td>t&lt;sub&gt;Cal&lt;/sub&gt; &gt; t&lt;sub&gt;Tab&lt;/sub&gt;</td>
</tr>
<tr>
<td>Science related attitude of F.I Male</td>
<td>97</td>
<td>3.7647</td>
<td>0.46598</td>
<td></td>
<td></td>
<td></td>
<td>2.882&gt;1.984</td>
</tr>
</tbody>
</table>

\[ t_{Cal} = \text{Calculated } t\text{-Value}, \quad t_{Tab} = \text{Tabulated } t\text{-Value}, \quad df = 304 \]

\[ p = \text{Significance Value}, \quad LOS = \text{Level of Significance} \]

Table 4.38 reflects the mean values of Science related attitude of Field-Dependent male and Field-Independent male of whole sample. For more clarity, the same data has been presented in the following graph.

*Figure 4.38 Mean Plot of Science related Attitude of Field–Dependents male and Field- Independents Male With respect to Gender*

**H<sub>07c</sub>. There may be no significant difference between science related attitude of F.D male and F.I male undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{Cal} \) was greater than \( t_{Tab} \) (2.882> 1.984, \( p= 0.004, \quad df=304 \)). It shows that there is significant difference (at 0.05 significance level) between mean values of science related attitude responses of Field-Dependent male and Field-Independent undergraduate science students of whole sample. Male F.I undergraduate science students possess more science related attitude than F.D male. Hence, the above hypothesis is rejected.
- Strata wise Analysis

Table 4.39 Science related Attitude of Field-Dependent male and Field-Independent male of Basic Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{cal}$</th>
<th>$t_{tab}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Male of Basic Sci. Strata</td>
<td>56</td>
<td>3.6174</td>
<td>0.5043</td>
<td>-1.672</td>
<td>2.000</td>
<td>0.099</td>
<td>t_{cal} &lt; $t_{tab}$</td>
</tr>
<tr>
<td>Science related attitude of F.I Male of Basic Sci.Strata</td>
<td>11</td>
<td>3.8897</td>
<td>0.4316</td>
<td></td>
<td></td>
<td></td>
<td>1.672 &lt; 2.000</td>
</tr>
</tbody>
</table>

$t_{cal} = \text{Calculated t-Value}, \quad t_{tab} = \text{Tabulated t-Value}, \quad df = 65$

$p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance}$

Table 4.39 reflects the mean values of Science related attitude of Field-Dependent male and Field-Independent male of basic science strata. For more clarity, the same data has been presented in the following graph.

**Figure 4.39** Mean Plot of Science related Attitude of Field-Dependent male and Field-Independent male of Basic Science Strata

$H_{07c}$. There may be no significant difference between science related attitude of F.D male and F.I male undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{cal}$ was less than $t_{tab}$ ($0.672 < 2.000, p = 0.099, df=65$). Although there was difference between mean values of science related attitude responses of Field-dependent male and Field-Independent male where male F.I have comparatively more science related attitude than F.D male undergraduate science students. However, the difference is not significant (0.05 significant level) between mean values of science related attitude responses of male Field-Dependents and male Field-Independents of basic science strata. Hence, the above hypothesis is accepted.
Table 4.40 *Science related Attitude of Field-Dependent male and Field-Independent male of Computer Science Strata*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{cal}} )</th>
<th>( t_{\text{tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Male of Computer Science Strata</td>
<td>40</td>
<td>3.4805</td>
<td>0.51583</td>
<td>-2.286</td>
<td>2.000</td>
<td>0.025</td>
<td>t ( \text{cal} ) &gt; ( t_{\text{tab}} )</td>
</tr>
<tr>
<td>Science related attitude of F.I Male of Computer Science Strata</td>
<td>31</td>
<td>3.7689</td>
<td>0.54172</td>
<td></td>
<td></td>
<td></td>
<td>2.286&gt;2.000</td>
</tr>
</tbody>
</table>

\( t_{\text{cal}} \) = Calculated t-Value, \( t_{\text{tab}} \) = Tabulated t-Value, \( df = 69 \)

\( p \) = Significance Value, LOS = Level of Significance

Table 4.40 reflects the mean values of Science related attitude of Field-Dependent male and Field-Independent male of Computer Science Strata. For more clarity, the same data has been presented in the following graph.

*Figure 4.40* Mean Plot of Science related Attitude of Field –Independents of Computer Science Strata with respect to Gender

**H07c. There may be no significant difference between science related attitude of F.D male and F.I male undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{\text{cal}} \) was greater than \( t_{\text{tab}} \) (2.286> 2.000, \( p = 0.025 \), \( df = 69 \)). It shows that there is significant difference (at 0.05 significance level) between mean values of science related attitude responses of Field-Dependent male and Field-Independent male undergraduate science students of Computer Science Strata. Male F.I undergraduate science students own more science related attitude than F.D male. Hence, the above hypothesis is rejected.
Table 4.41 *Science related Attitude Field-Dependent male and Field-Independent male of Field-Independent of Engineering Science Strata*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Male of Engr. Science Strata</td>
<td>113</td>
<td>3.5964</td>
<td>0.5757</td>
<td>-1.609</td>
<td>1.984</td>
<td>0.110</td>
<td>( t_{\text{Cal}} &lt; t_{\text{Tab}} )</td>
</tr>
<tr>
<td>Science related attitude of F.I Male of Engr. Science Strata</td>
<td>55</td>
<td>3.7373</td>
<td>0.4295</td>
<td>1.609&lt;1.984</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( t_{\text{Cal}} = \) Calculated t-Value, \( t_{\text{Tab}} = \) Tabulated t-Value, \( df = 166 \)

\( p = \) Significance Value, \( LOS = \) Level of Significance

Table 4.41 reflects the mean values of Science related attitude of Field-Dependent male and Field-Independent male of Engineering Science Strata. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Science related Attitude](image)

**Figure 4.41** Mean Plot of Science related Attitude of Field –Independents of Engineering Science Strata with respect to Gender

**H07c. There may be no significant difference between science related attitude of F.D male and F.I male undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was less than \( t_{\text{Tab}} \) (1.609 < 1.984, \( p=0.110 \), \( df=166 \)). Although there was difference between mean values of science related attitude responses of Field-Dependent male and Field-Independent male undergraduate science students. Male F.I have comparatively more science related attitude than F.D male. However, the difference is not significant (0.05 significant level). Hence, the above hypothesis is accepted.
d. **Science related Attitude of Field-Dependent female and Field-Independent female**

- **Whole Sample**

Table 4.42 *Science related Attitude of Field-Dependent female and Field – Independent female*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t&lt;sub&gt;Cal&lt;/sub&gt;</th>
<th>t&lt;sub&gt;Tab&lt;/sub&gt;</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Female</td>
<td>101</td>
<td>3.471</td>
<td>0.465</td>
<td>-4.407</td>
<td>1.984</td>
<td>0.000</td>
<td>t&lt;sub&gt;Cal&lt;/sub&gt; &gt; t&lt;sub&gt;Tab&lt;/sub&gt;</td>
</tr>
<tr>
<td>Science related attitude of F.I Female</td>
<td>124</td>
<td>3.742</td>
<td>0.470</td>
<td>4.407</td>
<td>1.984</td>
<td></td>
<td>4.407 &gt; 1.984</td>
</tr>
</tbody>
</table>

*t<sub>Cal</sub> = Calculated t-Value, t<sub>Tab</sub> = Tabulated t-Value, df = 223, p = Significance Value, LOS = Level of Significance*

Table 4.42 reflects the mean values of Science related attitude of Field-Dependent female and Field –Independent female of whole sample. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Science related Attitude of Field-Dependent female and Field –Independent female with respect to Gender](image)

**Figure 4.42 Mean Plot of Science related Attitude of Field-Dependent female and Field –Independent female with respect to Gender**

**H<sub>07d</sub>. There may be no significant difference between science related attitude of F.D female and F.I female undergraduate science students**

The t-test was implied and it was found that the calculated value of t<sub>Cal</sub> was greater than t<sub>Tab</sub> (4.407 > 1.984, p= 0.000, df=223). Female F.I undergraduate science students possess more science related attitude than female F.D. It shows that there is significant difference(at 0.05 significance level) between mean values of science related attitude responses of Field-Dependent female and Field –Independent female undergraduate science students of whole sample. Hence, the above hypothesis is rejected.
- Strata wise Analysis

Table 4.43 Science related Attitude of Field-Dependent female and Field – Independent female of Basic Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{cal}</th>
<th>t_{tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Female of Basic Sciences Strata</td>
<td>61</td>
<td>3.542</td>
<td>0.476</td>
<td>-3.225</td>
<td>1.984</td>
<td>0.002</td>
<td>t_{cal} &gt; t_{tab}</td>
</tr>
<tr>
<td>Science related attitude of F.I Female of Basic Sciences Strata</td>
<td>60</td>
<td>3.805</td>
<td>0.424</td>
<td></td>
<td></td>
<td></td>
<td>3.225&gt;1.98</td>
</tr>
</tbody>
</table>

\[ t_{cal} = \text{Calculated t-Value}, \quad t_{tab} = \text{Tabulated t-Value}, \quad df = 119 \]

\[ p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance} \]

Table 4.43 reflects the mean values of Science related attitude of Field-Dependent female and Field – Independent female of basic Science Strata. For more clarity, the same data has been presented in the following graph.

![Figure 4.43 Mean Plot of Science related attitude of Field-Dependent female and Field – Independent female of Basic Science Strata](image)

**H₀₇d. There may be no significant difference between science related attitude of F.D female and F.I female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{cal} \) was greater than \( t_{tab} \) (3.225 > 1.984, \( p = 0.002 \), \( df=119 \)). It shows that there is significant difference (at 0.05 significance level) between mean values of science related attitude responses of Field-Dependent female and Field – Independent female undergraduate science students of basic science strata. Female F.I own more science related attitude than female F.D undergraduate science students. Hence, the above hypothesis is rejected.
Table 4.44  Science related Attitude of Field-Dependent female and Field –Independent female of Computer Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Female of Comp. Science Strata</td>
<td>21</td>
<td>3.278</td>
<td>0.387</td>
<td>-1.357</td>
<td>2.048</td>
<td>0.186</td>
<td>1.357&lt;2.048</td>
</tr>
<tr>
<td>Science related attitude of F.I Female of Comp. Science Strata</td>
<td>9</td>
<td>3.520</td>
<td>0.566</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ t_{Cal} = \text{Calculated } t\text{-Value} , \quad t_{Tab} = \text{Tabulated } t\text{-Value} , \quad df = 28 \]
\[ p = \text{Significance Value} , \quad \text{LOS} = \text{Level of Significance} \]

Table 4.44 reflects the mean values of Science related attitude of Field-Dependent female and Field –Independent female of Computer Science Strata. For more clarity, the same data has been presented in the following graph.

\[ \text{Figure 4.44 Mean Plot of Science related Attitude of Field-Dependent female and Field –Independent female of Computer Science Strata} \]

H_{0}H_{0}. There may be no significant difference between science related attitude of F.D female and F.I female undergraduate science students

The t-test was implied and it was found that the calculated value of \( t_{Cal} \) was less than \( t_{Tab} \) (1.367 < 2.048, \( p=0.186\), \( df=28\)). Although there was difference between mean values of science related attitude of F.D female and F.I female. The Field-Independent female have comparatively more science related attitude than F.D female. However, there is no significant difference (0.05 significant level) between mean values of Science related attitude responses of female Field-Dependents and female Field-Independents of computer science strata. Hence, the above hypothesis is accepted.
Table 4.45  *Science related Attitude of Field-Dependent female and Field – Independent female of Engineering Science Strata*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{\text{cal}}$</th>
<th>$t_{\text{tab}}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of F.D Female of Engr.Science Strata</td>
<td>19</td>
<td>3.4587</td>
<td>0.3490</td>
<td>-2.039</td>
<td>2.000</td>
<td>0.045</td>
<td>$t_{\text{cal}} &gt; t_{\text{tab}}$</td>
</tr>
<tr>
<td>Science related attitude of F.I Female of Engr.Science Strata</td>
<td>55</td>
<td>3.7107</td>
<td>0.4968</td>
<td>2.039</td>
<td>2.000</td>
<td>0.047</td>
<td>$t_{\text{cal}} &gt; t_{\text{tab}}$</td>
</tr>
</tbody>
</table>

$t_{\text{cal}} = \text{Calculated t-Value, } t_{\text{tab}} = \text{Tabulated t-Value, } df = 72$

$p = \text{Significance Value, } LOS = \text{Level of Significance}$

Table 4.45 reflects the mean values of Science related attitude of Field-Dependent female and Field–Independent female of Engineering Science Strata. For more clarity, the same data has been presented in the following graph.

Figure 4.45 Mean Plot of Science related Attitude of Field-Dependent female and Field –Independent female of Engineering Science Strata

H$_{07d}$. There may be no significant difference between science related attitude of F.D female and F.I female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{\text{cal}}$ was greater than $t_{\text{tab}} (2.039 > 2.000, p= 0.047, df=72)$. Field-Independent female have more science related attitude than Field-Dependent female. There is significant difference (at 0.05 significance level) between mean values of Science related attitude responses of Field-Dependent female and Field–Independent female undergraduate science students of Engineering Science Strata. Hence, the above hypothesis is rejected.
Section-II

Analysis of Science related Attitude between male and female with respect to Convergent/Divergent Cognitive Learning Style

Table 4.46 Science related Attitude of Convergent and Divergent of Whole Sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of CON</td>
<td>200</td>
<td>3.4690</td>
<td>0.4760</td>
<td>-6.484</td>
<td>1.962</td>
<td>0.000</td>
<td>t_{Cal} &gt; t_{Tab}</td>
</tr>
<tr>
<td>Science related attitude of DIV</td>
<td>191</td>
<td>3.7848</td>
<td>0.4870</td>
<td></td>
<td></td>
<td></td>
<td>6.484 &gt; 1.962</td>
</tr>
</tbody>
</table>

\( t_{Cal} = \) Calculated t-Value, \( t_{Tab} = \) Tabulated t-Value, \( df = 389 \)

\( p = \) Significance Value, \( LOS = \) Level of Significance

Table 4.46 reflects the mean values of Science related attitude of Convergent and Divergent of whole sample. For more clarity, the same data has been presented in the following graph.

\[ Figure \ 4.46 \] Mean Plot of Science related Attitude of Convergent and Divergent of Whole Sample

\( H_08. \) There may be no difference between science related attitude of undergraduate science students having Convergent and Divergent cognitive learning styles

The t-test was implied and it was found that the calculated value of \( t_{Cal} \) was greater than \( t_{Tab} \) (6.484 > 1.962, \( p=0.000, \ df=329 \)). The mean value of science related attitude of Convergent undergraduate science students was higher than Divergents. There is highly significant difference (at 0.05 significance level) between mean values of Science related attitude responses of Convergent and Divergent of whole sample. Hence, the above hypothesis is rejected.
a. Science related Attitude of male and female with respect to Convergent Cognitive Learning Style

- Whole Sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{cal}} )</th>
<th>( t_{\text{tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of CON Male</td>
<td>153</td>
<td>3.480</td>
<td>0.470</td>
<td>0.602</td>
<td>1.984</td>
<td>0.548</td>
<td>( t_{\text{cal}} &lt; t_{\text{tab}} )</td>
</tr>
<tr>
<td>Science related attitude of CON Female</td>
<td>47</td>
<td>3.432</td>
<td>0.495</td>
<td>( t_{\text{cal}} &lt; t_{\text{tab}} )</td>
<td>0.602&lt;1.98</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( t_{\text{cal}} = \) Calculated t-Value, \( t_{\text{tab}} = \) Tabulated t-Value, \( df = 198 \)
\( p = \) Significance Value, LOS = Level of Significance

Table 4.47 reflects the mean values of Science related attitude of male and female Convergent. For more clarity, the same data has been presented in the following graph.

![Graph](image)

**Figure 4.47** Mean Plot of Science related attitude of Convergent with respect to Gender

**H_{08a}. There may be no significant difference between science related attitude of CON male and CON female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{\text{cal}} \) was less than \( t_{\text{tab}} \) (0.602< 1.984, \( p=0.548 \), \( df=198 \)). It shows that there is no significant difference (at 0.05 significance level) between mean values of Science related attitude responses of convergent male and female undergraduate science students of whole sample. Hence, the above hypothesis is accepted.
• Strata wise Analysis

Table 4.48 Science related Attitude of Convergent of Basic Science Strata with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of CON Male of Basic Sci. Strata</td>
<td>35</td>
<td>3.429</td>
<td>0.465</td>
<td></td>
<td></td>
<td>0.426</td>
<td>2.00 0.671</td>
</tr>
<tr>
<td>Science related attitude of CON Female of Basic Sci. Strata</td>
<td>31</td>
<td>3.377</td>
<td>0.527</td>
<td></td>
<td></td>
<td>0.426</td>
<td>&lt; 2.000</td>
</tr>
</tbody>
</table>

| t_{Cal} = Calculated t-Value, t_{Tab} = Tabulated t-Value, df = 64 |
| p = Significance Value, LOS = Level of Significance |

Table 4.48 reflects the mean values of Science related attitude of male and female Convergent of basic science strata. For more clarity, the same data has been presented in the following graph.

Figure 4.48 Mean Plot of Science related Attitude of Convergent of Basic Science Strata with respect to Gender

H_{08a}. There may be no significant difference between science related attitude of CON male and CON female undergraduate science students

The t-test was implied and it was found that the calculated value of t_{Cal} was less than t_{Tab} (0.426 < 2.000, p = 0.671, df=64). Although convergent undergraduate science male science students possess comparatively more science related attitude than Convergent female. However, there is no significant difference (0.05 significant level) between mean values of Science related attitude responses of male convergent and female convergent undergraduate science students of basic science strata. Hence, the above hypothesis is accepted.
Table 4.49  *Science related Attitude of Convergent of Computer Science Strata with respect to Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{Cal}$</th>
<th>$t_{Tab}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude</td>
<td>40</td>
<td>3.4065</td>
<td>0.42579</td>
<td>0.486</td>
<td>2.021</td>
<td>0.629</td>
<td>$t_{Cal} &lt; t_{Tab}$</td>
</tr>
<tr>
<td>of CON Male of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.486&lt;2.021</td>
</tr>
<tr>
<td>Comp. Sci. Strata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science related attitude</td>
<td>3</td>
<td>3.2833</td>
<td>0.36171</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>of CON Female of</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp. Sci. Strata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$t_{Cal} = \text{Calculated } t\text{-Value}$, $t_{Tab} = \text{Tabulated } t\text{-Value}$, $df = 41$

$p = \text{Significance Value}$, LOS = Level of Significance

Table 4.49 reflects the mean values of Science related attitude of male and female Convergent of computer science strata. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Science related Attitude of Convergent of Computer Science Strata with respect to Gender](image)

*Figure 4.49* Mean Plot of Science related Attitude of Convergent of Computer Science Strata with respect to Gender

**H08a. There may be no significant difference between science related attitude of CON male and CON female undergraduate science students**

The t-test was implied and it was found that the calculated value of $t_{Cal}$ was less than $t_{Tab}$ (0.486 < 2.021, $p=0.629$, $df=41$). Although there was difference between mean values of science related attitude of convergent male female undergraduate science students. The Convergent males have comparatively more science related attitude than Convergent female of computer science strata. However, the difference is not significant (0.05 significant level). Hence, the above hypothesis is accepted.
Table 4.50 Science related Attitude of Convergent of Engineering Science Strata with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t Cal</th>
<th>t Tab</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of CON Male of Engr. Sci. Strata</td>
<td>78</td>
<td>3.540</td>
<td>0.492</td>
<td>-0.388</td>
<td>1.990</td>
<td>0.699</td>
<td>&lt;</td>
</tr>
<tr>
<td>Science related attitude of CON Female of Engr. Sci. Strata</td>
<td>19</td>
<td>3.596</td>
<td>0.428</td>
<td></td>
<td></td>
<td></td>
<td>0.388&lt;1.990</td>
</tr>
</tbody>
</table>

$t_{\text{Cal}} =$ Calculated t-Value, $t_{\text{Tab}} =$ Tabulated t-Value, $df =$ 89
$p =$ Significance Value, LOS = Level of Significance

Table 4.50 reflects the mean values of Science related attitude of male and female Convergent of engineering science strata. For more clarity, the same data has been presented in the following graph.

![Figure 4.50 Mean Plot of Science related Attitude of Convergent of Engineering Science Strata with respect to Gender](image)

**H08a. There may be no significant difference between science related attitude of CON male and CON female undergraduate science students**

The t-test was implied and it was found that the calculated value of $t_{\text{Cal}}$ was less than $t_{\text{Tab}} (0.388 < 1.990, p= 0.699, df=89)$. It shows that there is no significant difference (at 0.05 significance level) between mean values of Science related attitude responses of male and female convergent undergraduate science students of engineering science strata. Hence, the above hypothesis is accepted.
b. Science related Attitude of male and female with respect to Divergent Cognitive Learning Style

- Whole Sample

Table 4.51 Science related Attitude of Divergent with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of DIV Male</td>
<td>59</td>
<td>3.814</td>
<td>0.503</td>
<td>0.571</td>
<td>1.984</td>
<td>0.569</td>
<td></td>
</tr>
<tr>
<td>Science related attitude of DIV Female</td>
<td>132</td>
<td>3.771</td>
<td>0.480</td>
<td>t_{\text{Cal}} = Calculated t-Value, ( t_{\text{Tab}} = ) Tabulated t-Value, ( df = 189 )</td>
<td>p = Significance Value, LOS = Level of Significance</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.51 reflects the mean values of Science related attitude of male and female Divergent of whole sample. For more clarity, the same data has been presented in the following graph.

Figure 4.51 Mean Plot of Science related Attitude of Divergent with respect to Gender

H_{0b}. There may be no significant difference between science related attitude of DIV male and DIV female undergraduate science students

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was less than \( t_{\text{Tab}} \) (0.571 < 1.984, \( p = 0.569 \), \( df=189 \)). Although divergent males have comparatively more science related attitude than Divergent female. However, there is no significant difference (0.05 significant level) between mean values of Science related attitude responses of male divergent undergraduate science students and female divergents of whole sample. Hence, the above hypothesis is accepted.
- **Strata wise Analysis**

  **Table 4.52**  Science related Attitude of Divergent of Basic Science Strata with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{cal}} )</th>
<th>( t_{\text{tab}} )</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of DIV Male of Basic Sci. Strata</td>
<td>12</td>
<td>3.727</td>
<td>0.421</td>
<td>-1.551</td>
<td>2.00</td>
<td>0.125</td>
<td>t_{\text{cal}} &lt; t_{\text{tab}}</td>
</tr>
<tr>
<td>Science related attitude of DIV Female of Basic Sci. Strata</td>
<td>65</td>
<td>3.927</td>
<td>0.408</td>
<td></td>
<td></td>
<td></td>
<td>1.551&lt;2.000</td>
</tr>
</tbody>
</table>

\( t_{\text{cal}} = \) Calculated t-Value , \( t_{\text{tab}} = \) Tabulated t-Value, \( df = 75 \)

\( p = \) Significance Value, \( \text{LOS} = \) Level of Significance

Table 4.52 reflects the mean values of Science related attitude of male and female Divergent of basic science strata. For more clarity, the same data has been presented in the following graph.

![Graph](image)

**Figure 4.52** Mean Plot of Science related Attitude of Divergent of Basic Science Strata with respect to Gender

**H08b. There may be no significant difference between science related attitude of DIV male and DIV female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{\text{cal}} \) was less than \( t_{\text{tab}} \) (1.551 < 2.000, \( p = 0.125, \ df=75 \)). Although divergent female undergraduate science students have comparatively more science related attitude than Divergent male. However, there is no significant difference (0.05 significant level) between mean values of Science related attitude responses of male divergents and female divergent undergraduate science students of basic science strata. Hence, the above hypothesis is accepted.
Table 4.53  

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{\text{Cal}}$</th>
<th>$t_{\text{Tab}}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of DIV Male of Comp. Science Strata</td>
<td>16</td>
<td>3.787</td>
<td>0.456</td>
<td>1.588</td>
<td>2.042</td>
<td>0.121</td>
<td>1.588 &lt; 2.042</td>
</tr>
<tr>
<td>Science related attitude of DIV Female of Comp. Science Strata</td>
<td>21</td>
<td>3.540</td>
<td>0.4783</td>
<td>1.588</td>
<td>2.042</td>
<td>0.121</td>
<td>1.588 &lt; 2.042</td>
</tr>
</tbody>
</table>

$t_{\text{Cal}} = \text{Calculated } t\text{-Value, } t_{\text{Tab}} = \text{Tabulated } t\text{-Value, } df = 35$

$p = \text{Significance Value, } LOS = \text{Level of Significance}$

Table 4.53 reflects the mean values of Science related attitude of male and female Divergent of computer science strata. For more clarity, the same data has been presented in the following graph.

Figure 4.53 Mean Plot of Science related Attitude of Divergent of Computer Science Strata with respect to Gender

$H_{08b}$. There may be no significant difference between science related attitude of DIV male and DIV female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{\text{Cal}}$ was less than $t_{\text{Tab}}$ ($1.588 < 2.042$, $p = 0.121$, $df=35$). Although there was difference between mean values of science related attitude of DIV male and DIV female undergraduate science students. The Divergent males have comparatively more science related attitude than Divergent female of computer science strata. However, the difference is not significant (0.05 significant level). Hence, the above hypothesis is accepted.
Table 4.54  *Science related Attitude of Divergent of Engineering Science Strata with respect to Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{Cal}$</th>
<th>$t_{Tab}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of DIV Male of Engr. Sci.Strata</td>
<td>31</td>
<td>3.862</td>
<td>0.429</td>
<td>1.675</td>
<td>2.000</td>
<td>0.098</td>
<td>$t_{Cal} &lt; t_{Tab}$</td>
</tr>
<tr>
<td>Science related attitude of DIV Female of Engr. Sci.Strata</td>
<td>46</td>
<td>3.656</td>
<td>0.496</td>
<td></td>
<td></td>
<td></td>
<td>1.675&lt;2.000</td>
</tr>
</tbody>
</table>

$t_{Cal} = \text{Calculated t-Value,} \quad t_{Tab} = \text{Tabulated t-Value,} \quad df = 75 \quad p = \text{Significance Value,} \quad LOS = \text{Level of Significance}$

Table 4.54 reflects the mean values of Science related attitude of male and female Divergent of engineering science Strata. For more clarity, the same data has been presented in the following graph.

*Figure 4.54 Mean Plot of Science related Attitude of Divergent of Engineering Science Strata with respect to Gender*

**H$_{08b}$. There may be no significant difference between science related attitude of DIV male and DIV female undergraduate science students**

The $t$-test was implied and it was found that the calculated value of $t_{Cal}$ was less than $t_{Tab}$ ($1.675 < 2.000$, $p=0.098$, $df=75$). Although divergent males have comparatively more science related attitude than Divergent female. However, there is no significant difference (0.05 significant level) between mean values of Science related attitude responses of male divergers and female divergers of Engineering Science Strata. Hence, the above hypothesis is accepted.
c. Science related Attitude of Convergent male and Divergent male
   - Whole Sample

Table 4.55: Science related Attitude of Convergent male and Divergent male

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t&lt;sub&gt;Cal&lt;/sub&gt;</th>
<th>t&lt;sub&gt;Tab&lt;/sub&gt;</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of CON Male</td>
<td>153</td>
<td>3.480</td>
<td>0.470</td>
<td>4.548</td>
<td>-1.984</td>
<td>0.000</td>
<td>&gt; t&lt;sub&gt;Tab&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>t&lt;sub&gt;Cal&lt;/sub&gt; &gt; t&lt;sub&gt;Tab&lt;/sub&gt;</td>
</tr>
<tr>
<td>Science related attitude of DIV Male</td>
<td>59</td>
<td>3.814</td>
<td>0.503</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ t_{Cal} = \text{Calculated t-Value}, \quad t_{Tab} = \text{Tabulated t-Value}, \quad df = 210 \]
\[ p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance} \]

Table 4.55 reflects the mean values of Science related attitude of Convergent male and Divergent male of whole sample. For more clarity, the same data has been presented in the following graph.

Figure 4.55 Mean Plot of Science related Attitude of Convergent male and Divergent male

**H<sub>0</sub>c.** There may be no significant difference between science related attitude of CON male and DIV male undergraduate science students

The t-test was implied and it was found that the calculated value of \( t_{Cal} \) was greater than \( t_{Tab} \) (4.548 > 1.984, \( p = 0.000, \quad df = 210 \)). The Divergent male undergraduate science students have comparatively more science related attitude than Convergent male. It shows that there is significant difference (at 0.05 significance level) between mean values of Science related attitude responses of Convergent male and Divergent male undergraduate science students of whole sample. Hence, the above hypothesis is rejected.
- **Strata wise Analysis**

Table 4.56  *Science related Attitude of Convergent male and Divergent male of Basic Science Strata*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{cal}} )</th>
<th>( t_{\text{tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of CON Male of Basic Sci. Strata</td>
<td>35</td>
<td>3.4298</td>
<td>0.4653</td>
<td>-1.955</td>
<td>2.021</td>
<td>0.057</td>
<td>( t_{\text{cal}} &lt; t_{\text{tab}} )</td>
</tr>
<tr>
<td>Science related attitude of DIV Male of Basic Sci. Strata</td>
<td>12</td>
<td>3.7274</td>
<td>0.4218</td>
<td>1.955</td>
<td>2.021</td>
<td>1.955&lt;2.021</td>
<td></td>
</tr>
</tbody>
</table>

\( t_{\text{cal}} = \) Calculated t-Value, \( t_{\text{tab}} = \) Tabulated t-Value, \( df = 45 \)

\( p = \) Significance Value,  \( LOS = \) Level of Significance

Table 4.56 reflects the mean values of Science related attitude of Convergent male and Divergent male of basic science strata. For more clarity, the same data has been presented in the following graph.

![Graph showing mean plot](image)

*Figure 4.56 Mean Plot of Science related Attitude of Convergent male and Divergent male of Basic Science Strata*

**H\( _{05c} \): There may be no significant difference between science related attitude of CON male and DIV male undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{\text{cal}} \) was less than \( t_{\text{tab}} \) (1.955 < 2.021, \( p = 0.057, \ df=45 \)). Although divergent males undergraduate science students have comparatively more science related attitude than Convergent male. However, the difference between mean values of Science related attitude responses of male convergers and male divergers of basic science strata is not significant (at 0.05 significance level). Hence, the above hypothesis is accepted.
Table 4.57  

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{cal} )</th>
<th>( t_{tab} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of CON Male of Comp. Sci.Strata</td>
<td>40</td>
<td>3.406</td>
<td>0.425</td>
<td>-2.968</td>
<td>2.021</td>
<td>0.004</td>
<td>( t_{cal} &gt; t_{tab} )</td>
</tr>
<tr>
<td>Science related attitude of DIV Male of Comp. Sci.Strata</td>
<td>16</td>
<td>3.787</td>
<td>0.456</td>
<td></td>
<td></td>
<td></td>
<td>2.968&gt;2.021</td>
</tr>
</tbody>
</table>

\( t_{cal} \) = Calculated t-Value, \( t_{tab} \) = Tabulated t-Value, \( df = 54 \)

\( p \) = Significance Value, LOS = Level of Significance

Table 4.57 reflects the mean values of Science related attitude of Convergent male and Divergent male. For more clarity, the same data has been presented in the following graph.

![Figure 4.57 Mean Plot of Science related Attitude of Convergent male and Divergent male of Computer Science Strata](image)

**Figure 4.57** Mean Plot of Science related Attitude of Convergent male and Divergent male of Computer Science Strata

**H_{08c}**: There may be no significant difference between science related attitude of CON male and DIV male undergraduate science students

The t-test was implied and it was found that the calculated value of \( t_{cal} \) was greater than \( t_{tab} \) (2.968>2.021, \( p= 0.004 \), \( df=54 \)). The Divergent males undergraduate science students have comparatively more science related attitude than Convergent male. It shows that there is significant difference (at 0.05 significance level) between mean values of Science related attitude responses of convergent male and divergent male of computer science strata. Hence, the above hypothesis is rejected.
Table 4.58 Science related Attitude of Convergent male and Divergent male of Engineering Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{\text{Cal}}$</th>
<th>$t_{\text{Tab}}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of CON Male of Engr.Sci.Strata</td>
<td>78</td>
<td>3.5406</td>
<td>0.4924</td>
<td>-2.958</td>
<td>1.984</td>
<td>0.004</td>
<td>$t_{\text{Cal}} &gt; t_{\text{Tab}}$</td>
</tr>
<tr>
<td>Science related attitude of DIV Male of Engr.Sci.Strata</td>
<td>31</td>
<td>3.8627</td>
<td>0.5619</td>
<td></td>
<td></td>
<td></td>
<td>2.958&gt;1.984</td>
</tr>
</tbody>
</table>

$t_{\text{Cal}} = \text{Calculated t-Value}$, $t_{\text{Tab}} = \text{Tabulated t-Value}$, $df = 107$

$p = \text{Significance Value}$, LOS = Level of Significance

Table 4.58 reflects the mean values of Science related attitude of Convergent male and Divergent male of engineering sciences strata. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Science related attitude of Convergent and Divergent male of Engineering Science Strata](image)

**Figure 4.58 Mean Plot of Science related Attitude of Convergent male and Divergent male of Engineering Science Strata**

**H$_{05c}$. There may be no significant difference between science related attitude of CON male and DIV male undergraduate science students**

The t-test was implied and it was found that the calculated value of $t_{\text{Cal}}$ was greater than $t_{\text{Tab}}$ (2.958> 1.984, p= 0.004, $df=107$). The Divergent males undergraduate science students have significantly more science related attitude than Convergent male. It shows that there is significant difference (at 0.05 significance level) between mean values of Science related attitude responses of convergent male and divergent male undergraduate science students of engineering science strata. Hence, the above hypothesis is rejected.
d. Science related Attitude of Convergent female and Divergent female

- Whole Sample

Table 4.59 Science related Attitude of Convergent female and Divergent female

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{cal}</th>
<th>t_{tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of CON Female</td>
<td>47</td>
<td>3.432</td>
<td>0.495</td>
<td>-4.117</td>
<td>1.984</td>
<td>0.000</td>
<td>&gt;</td>
</tr>
<tr>
<td>Science related attitude of DIV Female</td>
<td>132</td>
<td>3.771</td>
<td>0.480</td>
<td></td>
<td></td>
<td></td>
<td>4.117&gt;1.984</td>
</tr>
</tbody>
</table>

$t_{\text{cal}}$ = Calculated t-Value, $t_{\text{tab}}$ = Tabulated t-Value, $df$ = 177, $p$ = Significance Value, LOS = Level of Significance

Table 4.59 reflects the mean values of Science related attitude of Convergent female and Divergent female of whole sample. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Science related Attitude of Convergent female and Divergent female](image)

*Figure 4.59 Mean Plot of Science related Attitude of Convergent female and Divergent female*

H_{08d}. There may be no significant difference between science related attitude of CON female and DIV female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{\text{cal}}$ was greater than $t_{\text{tab}}$ (4.117 > 1.984, p= 0.000, df=177). The Divergent female undergraduate science students have comparatively more science related attitude than Convergent female. It shows that there is significant difference (at 0.05 significance level) between science related attitude responses of Convergent female and divergent female undergraduate science students. Hence, the above hypothesis is rejected.
• Strata wise Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{\text{cal}}$</th>
<th>$t_{\text{tab}}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of CON Female of Basic Sci.Strata</td>
<td>31</td>
<td>3.377</td>
<td>0.527</td>
<td>5.598</td>
<td>1.990</td>
<td>0.000</td>
<td>$t_{\text{cal}} &gt; t_{\text{tab}}$</td>
</tr>
<tr>
<td>Science related attitude of DIV Female of Basic Sci.Strata</td>
<td>65</td>
<td>3.927</td>
<td>0.408</td>
<td></td>
<td></td>
<td></td>
<td>5.598&gt;1.990</td>
</tr>
</tbody>
</table>

$t_{\text{cal}} = \text{Calculated } t\text{-Value, } t_{\text{tab}} = \text{Tabulated } t\text{-Value, } df = 94$

$p = \text{Significance Value, } LOS = \text{Level of Significance}$

Table 4.60 reflects the mean values of Science related attitude of Convergent Female and Divergent Female of basic Science Strata. For more clarity, the same data has been presented in the following graph.

![Graph showing mean plot](image)

Figure 4.60 Mean Plot of Science related Attitude of Convergent Female and Divergent Female of Basic Science Strata

$H_{08d}$. There may be no significant difference between science related attitude of CON female and DIV female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{\text{cal}}$ was greater than $t_{\text{tab}}$ (5.598>1.990, $p= 0.000$, $df=94$). The Divergent female undergraduate science students have comparatively more science related attitude than Convergent female. It shows that there is significant difference (at 0.05 significance level) between mean values of Science related attitude responses of Convergent female and Divergent female of basic sciences strata. Hence, the above hypothesis is rejected.
Table 4.6 reflects the mean values of Science related attitude of Convergent Female and Divergent Female of Computer Science Strata. For more clarity, the same data has been presented in the following graph.

**Figure 4.61 Mean Plot of Science related Attitude of Convergent Female and Divergent Female of Computer Science Strata**

**H₀₈d. There may be no significant difference between science related attitude of CON female and DIV female undergraduate science students**

The t-test was implied and it was found that the calculated value of $t_{cal}$ was less than $t_{tab}$ ($0.888 < 2.074, p = 0.384, df=22$). Although Divergent female have comparatively more science related attitude than Convergent female undergraduate science students. However, the difference between mean values of Science related attitude responses of female convergers and female divergers of Computer Engineering Strata is not significant (at 0.05 significance level). Hence, the above hypothesis is accepted.
Table 4.62  

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{\text{Cal}}$</th>
<th>$t_{\text{Tab}}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude of CON Female of Engr.Sci.Strata</td>
<td>13</td>
<td>3.5969</td>
<td>0.4283</td>
<td>-0.381</td>
<td>2.021</td>
<td>0.705</td>
<td>t_{\text{Cal}} &lt; t_{\text{Tab}}</td>
</tr>
<tr>
<td>Science related attitude of DIV Female of Engr.Sci. Strata</td>
<td>46</td>
<td>3.6560</td>
<td>0.5096</td>
<td></td>
<td></td>
<td></td>
<td>0.381&lt;2.021</td>
</tr>
</tbody>
</table>

$t_{\text{Cal}}$ = Calculated t-Value,  
$t_{\text{Tab}}$ = Tabulated t-Value,  
$df$ = 57  
$p$ = Significance Value,  
LOS = Level of Significance

Table 4.62 reflects the mean values of Science related attitude Convergent Female and Divergent Female of Engineering Science Strata. For more clarity, the same data has been presented in the following graph.

![Graph showing mean plot of science related attitude](image)

Figure 4.62 Mean Plot of Science related Attitude of Convergent Female and Divergent Female of Engineering Science Strata

H$_{0\text{sd}}$. There may be no significant difference between science related attitude of CON female and DIV female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{\text{Cal}}$ was less than $t_{\text{Tab}}$ (0.381 < 2.021, p = 0.705, $df$=57). Although Divergent female undergraduate science students have comparatively more science related attitude than Convergent female. However, the difference between mean values of Science related attitude responses of female convergers and female divergers of Engineering Science Strata is not significant (at 0.05 significance level). Hence, the above hypothesis is accepted.
PART-V

Analysis of Academic Achievement between Male and Female with respect to Cognitive Styles of Learning

In this part, the analysis of mean value of Academic Achievement of undergraduate science students with respect to Cognitive Styles of Learning have been analyzed and presented. The sample consisted of male and female students of undergraduate science students. This section is divided into following subsections:

Section-I Analysis of Academic Achievement of male and female with respect to Field-Dependent/Field-Independent Cognitive Learning Style

a. Academic Achievement of Field-Dependent male and Field-Dependent female
b. Academic Achievement of Field-Independent male and Field-Independent female
c. Academic Achievement of Field-Dependent male and Field-Independent male
d. Academic Achievement of Field-Dependent female and Field-Independent female

Section-II Analysis of Academic Achievement of male and female with respect to Convergent/Divergent Cognitive Learning Style

a. Academic Achievement of Convergent male and Convergent female
b. Academic Achievement of Divergent male and Divergent female
c. Academic Achievement of Convergent male and Divergent male
d. Academic Achievement of Convergent female and Divergent female

In this part, the mean values of Academic Achievement of whole sample with respect to Cognitive styles of Learning have been analyzed. The hypotheses were tested by applying following “t test”.

\[ t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}} \]

Where
where \( \bar{x}_1 \) = mean of sample 1
\( \bar{x}_2 \) = mean of sample 2
\( n_1 \) = number of subjects in sample 1
\( n_2 \) = number of subjects in sample 2
\( s_1^2 \) = variance of sample 1 = \( \frac{\sum(x_1 - \bar{x}_1)^2}{n_1} \)
\( s_2^2 \) = variance of sample 2 = \( \frac{\sum(x_2 - \bar{x}_2)^2}{n_2} \)

The data was tabulated and graphically presented.

**Section-I**

**Analysis of Academic Achievement with respect to Field-Dependent/Field-Independent Cognitive Learning Style**

In this section analysis of academic achievement with respect to Field-Dependent/Field-Independent cognitive learning style have been presented.
Table 4.63  

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_Cal</th>
<th>t_Tab</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D</td>
<td>310</td>
<td>2.5851</td>
<td>0.7388</td>
<td>-7.699</td>
<td>1.962</td>
<td>0.000</td>
<td>t_Cal &gt; t_Tab</td>
</tr>
<tr>
<td>Academic Achievement of F.I</td>
<td>221</td>
<td>3.0643</td>
<td>0.6596</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( t_{\text{Cal}} = \text{Calculated t-Value}, \quad t_{\text{Tab}} = \text{Tabulated t-Value}, \quad df = 529 \)

\( p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance} \)

Table 4.63 reflects the mean values of Academic Achievement of Field–Dependent and Field-Independent of whole sample. For more clarity, the same data has been presented in the following graph.

*Figure 4.63 Mean Plot of Academic Achievement of F.D and F.I of Whole Sample*

**Hypothesis:** There may be no significant difference between academic achievement of undergraduate science students having Field Dependent and Field Independent cognitive learning styles

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was greater than \( t_{\text{Tab}} \) (7.699 > 1.962, \( p = 0.000, \quad df=529 \)). Field-Independents undergraduate science students have higher academic achievement than Field-Dependents undergraduate science students of whole sample. The difference is highly significant (at 0.05 significance level). Hence, the above hypothesis is rejected.
Table 4.64  
*Mean values of Academic Achievement of Field-Dependent With Respect To Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{Cal} )</th>
<th>( t_{Tab} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D Male</td>
<td>209</td>
<td>2.5442</td>
<td>.7482</td>
<td>-1.403</td>
<td>1.962</td>
<td>0.162</td>
<td>t_{Cal} &lt; t_{Tab}</td>
</tr>
<tr>
<td>Academic Achievement of F.D Female</td>
<td>101</td>
<td>2.6696</td>
<td>.71504</td>
<td>.1403</td>
<td>1.962</td>
<td>1.403 &lt; 1.962</td>
<td></td>
</tr>
</tbody>
</table>

\( t_{Cal} = \) Calculated t-Value, \( t_{Tab} = \) Tabulated t-Value, \( df = 308 \)
\( p = \) Significance Value, \( LOS = \) Level of Significance

Table 4.64 reflects the mean values of Academic Achievement of Field-Dependents male and female of whole sample. For more clarity, the same data has been presented in the following graph.

*Figure 4.64 Mean Plot of Academic Achievement of Field–Dependents of Whole Sample with respect to Gender*

**H\(^{09a}\). There may be no significant difference between academic achievement of F.D male and F.D female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{Cal} \) was less than \( t_{Tab} \) (1.403 < 1.962, \( p = 0.162, \ df = 308 \)). Although Field-Dependent females undergraduate science students have comparatively more academic achievement than Field-Dependent male. However, the difference between mean values of Academic Achievement of male Field-Dependent and female Field-dependent of whole sample is not significant (at 0.05 significance level). Hence, the above hypothesis is accepted.
Strata wise Analysis

Table 4.65  Academic Achievement of Field-Dependent of Basic Science Strata With Respect To Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{cal}</th>
<th>t_{tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D Male of Basic Sciences Strata</td>
<td>56</td>
<td>2.624</td>
<td>.9137</td>
<td>0.312</td>
<td>1.962</td>
<td>0.755</td>
<td>t_{cal} &lt; t_{tab}</td>
</tr>
<tr>
<td>Academic Achievement of F.D Female of Basic Sciences Strata</td>
<td>61</td>
<td>2.575</td>
<td>.7645</td>
<td></td>
<td></td>
<td></td>
<td>0.312&lt;1.962</td>
</tr>
</tbody>
</table>

\( t_{cal} = \) Calculated t-Value, \( t_{tab} = \) Tabulated t-Value, \( df = 115 \)
\( p = \) Significance Value, \( LOS = \) Level of Significance

Table 4.65 reflects the mean values of Academic Achievement of male and female Field-Dependents of basic science strata. For more clarity, the same data has been presented in the following graph.

![Figure 4.65 Mean Plot of Academic Achievement of Field –Dependents of Basic Science Strata with respect to Gender](image)

\( H_{09a} \). There may be no significant difference between academic achievement of F.D male and F.D female undergraduate science students

The t-test was implied and it was found that the calculated value of \( t_{cal} \) was less than \( t_{tab} \) (0.312 < 1.962, \( p = 0.755, df=115 \)). Although Field-Dependent males undergraduate science students have comparatively more academic achievement than Field-Dependent female. However, the difference between mean values of Academic Achievement of male F.D and female F.D of basic Science Strata is not significant (at 0.05 significance level). Hence, the above hypothesis is accepted.
Table 4.66  
**Academic Achievement of Field-Dependent of Computer Science Strata a With Respect To Gender**

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{Cal}$</th>
<th>$t_{Tab}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D Male of Computer Science Strata</td>
<td>40</td>
<td>2.5070</td>
<td>.5906</td>
<td>-2.773</td>
<td>2.021</td>
<td>0.007</td>
<td>$t_{Cal} &gt; t_{Tab}$</td>
</tr>
<tr>
<td>Academic Achievement of F.D Female of Computer Science Strata</td>
<td>21</td>
<td>2.9395</td>
<td>.5548</td>
<td>2.773 &gt; 2.021</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$t_{Cal} = \text{Calculated t-Value}, \quad t_{Tab} = \text{Tabulated t-Value}, \quad df = 59$

$p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance}$

Table 4.66 reflects the mean values of Academic Achievement of male and female Field-Dependent of computer science strata. For more clarity, the same data has been presented in the following graph.

![Graph](image)

*Figure 4.66 Mean Plot of Academic Achievement of Field –Dependents of Computer Science Strata with respect to Gender*

**H09a. There may be no significant difference between academic achievement of F.D male and F.D female undergraduate science students**

The t-test was implied and it was found that the calculated value of $t_{Cal}$ was greater than $t_{Tab}$ (2.773 > 2.021, $p= 0.007$, $df=59$). The Field-Dependent female undergraduate science students have comparatively more academic achievement than Field-Dependent male. The difference between mean values of Academic Achievement of male Field-Dependent and female Field-dependent of computer science strata is significant (at 0.05 significance level). Hence, the above hypothesis is rejected.
Table 4.67  Academic Achievement of Field-Dependent of Engineering Science Strata with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D Male of Engr. Science Strata</td>
<td>113</td>
<td>2.517</td>
<td>.7099</td>
<td>-0.891</td>
<td>1.962</td>
<td>0.374</td>
<td>&lt; t_{Tab}</td>
</tr>
<tr>
<td>Academic Achievement of F.D Female of Engr. Science Strata</td>
<td>19</td>
<td>2.673</td>
<td>.6593</td>
<td></td>
<td></td>
<td></td>
<td>0.891&lt;1.962</td>
</tr>
</tbody>
</table>

\( t_{Cal} = \) Calculated \( t \)-Value, \( t_{Tab} = \) Tabulated \( t \)-Value, \( df = 130 \)
\( p = \) Significance Value, LOS = Level of Significance

Table 4.67 reflects the mean values of Academic Achievement of male and female Field-Dependents of engineering science strata. For more clarity, the same data has been presented in the following graph.

Figure 4.67 Mean Plot of Academic Achievement of Field –Dependents of Engineering Science Strata with respect to Gender

\( H_{09a}. \) There may be no significant difference between academic achievement of F.D male and F.D female undergraduate science students

The \( t \)-test was implied and it was found that the calculated value of \( t_{Cal} \) was less than \( t_{Tab} \) (0.891 < 1.962, \( p = 0.374, \) \( df=130 \)). Although Field-Dependent female undergraduate science students have comparatively more academic achievement than Field-Dependent male. However, the difference between mean values of Academic Achievement of male F.D and female F.D of engineering science strata is not significant (at 0.05 significance level). Hence, the above hypothesis is accepted.
b. Academic Achievement of Male and Female with Respect to Field-Independent Cognitive Learning Style

- Whole Sample

Table 4.68  Academic Achievement of Field-Independent with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.I Male</td>
<td>97</td>
<td>2.9375</td>
<td>.76171</td>
<td>-2.558</td>
<td>1.984</td>
<td>0.011</td>
<td>( t_{\text{Cal}} &gt; t_{\text{Tab}} )</td>
</tr>
<tr>
<td>Academic Achievement of F.I Female</td>
<td>124</td>
<td>3.1634</td>
<td>.55032</td>
<td></td>
<td></td>
<td></td>
<td>2.558 &gt; 1.984</td>
</tr>
</tbody>
</table>

\( t_{\text{Cal}} \) = Calculated t-Value, \( t_{\text{Tab}} \) = Tabulated t-Value, \( df = 219 \)
\( p \) = Significance Value, LOS = Level of Significance

Table 4.68 reflects the mean values of Academic Achievement of male and female Field-Independents of whole sample. For more clarity, the same data has been presented in the following graph.

Figure 4.68 Mean Plot of Academic Achievement of Field–Independents with respect to Gender

**H_{09b}. There may be no significant difference between academic achievement of F.I male and F.I female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was greater than \( t_{\text{Tab}} \) (2.558 > 1.984, \( p = 0.011 \), \( df=219 \)). The academic achievement of female Field-Independent undergraduate science students is greater than male Field-Independents. This difference is significant (at 0.05 significance level) hence, the above hypothesis is rejected and the alternate hypothesis is accepted i.e. there is significant difference between mean values of academic achievement of F.I male and F.I female.
• Strata wise Analysis

Table 4.69  Academic Achievement of Field-Independent of Basic Science Strata with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.I Male of Basic</td>
<td>11</td>
<td>2.7336</td>
<td>.46402</td>
<td>-1.479</td>
<td>2.000</td>
<td>0.144</td>
<td></td>
</tr>
<tr>
<td>Sciences Strata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Academic Achievement of F.I Female of Basic</td>
<td>60</td>
<td>3.1325</td>
<td>65393</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sciences Strata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| \( t_{Cal} = \) Calculated t-Value, \( t_{Tab} = \) Tabulated t-Value, \( df = 69 \)
| \( p = \) Significance Value, \( LOS = \) Level of Significance

Table 4.69 reflects the mean values of Academic Achievement of male and female Field-Independents of basic science strata. For more clarity, the same data has been presented in the following graph.

![Figure 4.69 Mean Plot of Academic Achievement of Field –Independents of Basic Science Strata with respect to Gender](image)

**H_09b.** There may be no significant difference between academic achievement of F.I male and F.I female undergraduate science students

The t-test was implied and it was found that the calculated value of \( t_{Cal} \) was less than \( t_{Tab} \) (1.479 < 2.000, \( p= 0.144, \) \( df=69 \)). Although Field-Independent undergraduate science students female have comparatively more academic achievement than Field-Independent male. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male F.I and female F.I of basic science strata. Hence, the above hypothesis is accepted.
Table 4.70  
*Academic Achievement of Field-Independent of Computer Science Strata with respect to Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.I Male of Computer Science Strata</td>
<td>31</td>
<td>2.7516</td>
<td></td>
<td>-1.257</td>
<td>2.042</td>
<td>0.216</td>
<td></td>
</tr>
</tbody>
</table>

\( t_{\text{Cal}} < t_{\text{Tab}} \)

\( 1.257 < 2.042 \)

Academic Achievement of F.I Female of Computer Science Strata | 9  | 3.0922|      | \( t_{\text{Cal}} \) = Calculated t-Value \(, \ t_{\text{Tab}} = \text{Tabulated t-Value}, \ df = 38 \)

\( p = \text{Significance Value,} \ LOS = \text{Level of Significance} \)

Table 4.70 reflects the mean values of Academic Achievement of male and female Field-Independents of computer science strata. For more clarity, the same data has been presented in the following graph.

*Figure 4.70 Mean Plot of Academic Achievement of Field –Independents of Computer Science Strata with respect to Gender*

**H09b. There may be no significant difference between academic achievement of F.I male and F.I female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was less than \( t_{\text{Tab}} \) (1.257 < 2.042, \( p = 0.216, \ df=38 \)). Although Field-Independent female undergraduate science students have comparatively more academic achievement than Field-Independent male. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male F.I and female F.I of computer science strata. Hence, the above hypothesis is accepted.
Table 4.7.1  Academic Achievement of Field-Independent of Engineering Science Strata with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t&lt;sub&gt;Cal&lt;/sub&gt;</th>
<th>t&lt;sub&gt;Tab&lt;/sub&gt;</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.I Male of Engr. Sci. Strata</td>
<td>55</td>
<td>3.0831</td>
<td>.5163</td>
<td>-1.400</td>
<td>1.984</td>
<td>0.64</td>
<td>1.400 &lt; 1.984</td>
</tr>
<tr>
<td>Academic Achievement of F.I Female of Engr. Sci. Strata</td>
<td>55</td>
<td>3.2087</td>
<td>.4199</td>
<td>t&lt;sub&gt;Cal&lt;/sub&gt; = Calculated t-Value, t&lt;sub&gt;Tab&lt;/sub&gt; = Tabulated t-Value, df = 108, p = Significance Value, LOS = Level of Significance</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.7.1 reflects the mean values of Academic Achievement of male and female Field-Independents of engineering science strata. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Academic Achievement](image)

**Figure 4.7.1** Mean Plot of Academic Achievement of Field –Independents of Engineering Science Strata with respect to Gender

**H<sub>0</sub>**<sb>9b</sb>. There may be no significant difference between academic achievement of F.I male and F.I female undergraduate science students

The t-test was implied and it was found that the calculated value of t<sub>Cal</sub> was less than t<sub>Tab</sub> (1.400 < 1.984, p= 0.064, df=108). Although Field-Independent female undergraduate science students have comparatively more academic achievement than Field-Independent male. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male F.I and female F.I of engineering science strata. Hence, the above hypothesis is accepted.
c. Academic Achievement between Field-Dependent male and Field-Independent male

- Whole Sample

Table 4.72 Academic Achievement of Field-Dependent Male and Field-Independent Male

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{Cal} )</th>
<th>( t_{Tab} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D Male</td>
<td>209</td>
<td>2.5442</td>
<td>.7482</td>
<td>-4.254</td>
<td>1.984</td>
<td>0.000</td>
<td>( t_{Cal} &gt; t_{Tab} )</td>
</tr>
<tr>
<td>Academic Achievement of F.I Male</td>
<td>97</td>
<td>2.9375</td>
<td>.7617</td>
<td>4.254&gt;1.984</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( t_{Cal} = \) Calculated t-Value, \( t_{Tab} = \) Tabulated t-Value, \( df = 304 \)

\( p = \) Significance Value, LOS = Level of Significance

Table 4.72 reflects the mean values of Academic Achievement of Field-Dependent male and Field-Independent male of whole sample. For more clarity, the same data has been presented in the following graph.

Figure 4.72 Mean Plot of Academic Achievement of Field–Dependents male and Field-Independents Male

\( H_09c. \) There may be no significant difference between academic achievement of F.D male and F.I male undergraduate science students

The t-test was implied and it was found that the calculated value of \( t_{Cal} \) was greater than \( t_{Tab} \) (4.254> 1.984, \( p = 0.000 \), \( df=304 \)). The F.I male have comparatively more academic achievement than F.D male undergraduate science students. There is significant difference (at 0.05 significance level) between mean values of Academic Achievement of male F.D and male F.I undergraduate science students of whole sample. Hence, the above hypothesis is rejected.

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• Strata wise Analysis

Table 4.73: Academic Achievement of Field-Dependent male and Field-Independent male of Basic Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{\text{Cal}}$</th>
<th>$t_{\text{Tab}}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D Male of Basic Sciences Strata</td>
<td>56</td>
<td>2.6241</td>
<td>.9137</td>
<td>-0.326</td>
<td>2.000</td>
<td>0.745</td>
<td>t_{\text{Cal}} &lt; t_{\text{Tab}}</td>
</tr>
<tr>
<td>Academic Achievement of F.I Male of Basic Sciences Strata</td>
<td>11</td>
<td>2.7336</td>
<td>1.4640</td>
<td></td>
<td></td>
<td></td>
<td>0.326 &lt; 2.00</td>
</tr>
</tbody>
</table>

$t_{\text{Cal}}$ = Calculated t-Value, $t_{\text{Tab}}$ = Tabulated t-Value, $df = 65$

$p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance}$

Table 4.73 reflects the mean values of Academic Achievement of Field-Dependent male and Field-Independent male of basic science strata. For more clarity, the same data has been presented in the following graph.

*Figure 4.73 Mean Plot of Academic Achievement of Field-Dependent male and Field-Independent male of Basic Science Strata*

**Hypothesis. There may be no significant difference between academic achievement of F.D male and F.I male undergraduate science students**

The t-test was implied and it was found that the calculated value of $t_{\text{Cal}}$ was less than $t_{\text{Tab}}$ ($0.326 < 2.000, p = 0.745, df=65$). Although Field-Independent male undergraduate science students have comparatively more academic achievement than Field-Dependent male. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male F.D and male F.I of basic science strata. Hence, the above hypothesis is accepted.
Table 4.74 Academic Achievement of Field-Dependent male and Field-Independent male of Computer Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{cal}</th>
<th>t_{tab}</th>
<th>p</th>
<th>At 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D Male of Computer Science Strata</td>
<td>40</td>
<td>2.5070</td>
<td>.5906</td>
<td>-1.531</td>
<td>2.000</td>
<td>0.130</td>
<td>1.531&lt;2.000</td>
</tr>
<tr>
<td>Academic Achievement of F.I Male of Computer Science Strata</td>
<td>31</td>
<td>2.7516</td>
<td>.7566</td>
<td>1.531</td>
<td>1.531&lt;2.000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
t_{\text{cal}} = \text{Calculated t-Value}, \quad t_{\text{tab}} = \text{Tabulated t-Value}, \quad df = 69 \quad p = \text{Significance Value}, \quad LOS = \text{Level of Significance}
\]

Table 4.74 reflects the mean values of Academic Achievement of Field-Dependent male and Field-Independent male of Computer Science Strata. For more clarity, the same data has been presented in the following graph.

![Figure 4.74 Mean Plot of Academic Achievement of Field –Independents of Computer Science Strata with respect to Gender](image)

\[H_0: \text{There may be no significant difference between academic achievement of F.D male and F.I male undergraduate science students}\]

The t-test was implied and it was found that the calculated value of \(t_{\text{cal}}\) was less than \(t_{\text{tab}}\) \((1.531<2.000, \quad p=0.130, \quad df=69)\). Although Field-Independent male undergraduate science students have comparatively more academic achievement than Field-Dependent male. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male F.D and male F.I of Computer Science Strata. Hence, the above hypothesis is accepted.
Table 4.75  

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of Field-Dependent male of Eng. Sci. Strata</td>
<td>113</td>
<td>2.5178</td>
<td>.70990</td>
<td>-5.263</td>
<td>1.984</td>
<td>0.000</td>
<td>t_{Cal} &gt; t_{Tab}</td>
</tr>
</tbody>
</table>

\[ t_{Cal} = \text{Calculated t-Value}, \quad t_{Tab} = \text{Tabulated t-Value}, \quad df = 166 \]
\[ p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance} \]

Table 4.75 reflects the mean values of Academic Achievement of Field-Dependent male and Field-Independent male of Engineering Science Strata. For more clarity, the same data has been presented in the following graph.

Figure 4.75 Mean Plot of Academic Achievement of Field-Dependent male and Field-Independent male of Engineering Science Strata

H_{09c}. There may be no significant difference between academic achievement of F.D male and F.I male undergraduate science students

The t-test was implied and it was found that the calculated value of \( t_{Cal} \) was greater than \( t_{Tab} \) (5.263 > 1.984, \( p = 0.000 \), \( df=166 \)). The Field-Independent male have comparatively more academic achievement than Field-Dependent male. The difference is significant (at 0.05 significance level) between mean values of Academic Achievement of male Field-dependent and male Field-Independent of Engineering Science Strata. Hence, the above hypothesis is rejected.
d. Academic Achievement of Field-Dependent Female and Field-Independent Female

- Whole Sample

Table 4.76 Academic Achievement of Field-Dependent Female and Field—Independent Female

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{\text{cal}}$</th>
<th>$t_{\text{tab}}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D Female</td>
<td>101</td>
<td>2.6696</td>
<td>.71504</td>
<td>-5.852</td>
<td>1.984</td>
<td>0.000</td>
<td>$t_{\text{cal}} &gt; t_{\text{tab}}$</td>
</tr>
<tr>
<td>Academic Achievement of F.I Female</td>
<td>124</td>
<td>3.1634</td>
<td>.55032</td>
<td>5.852&gt;1.984</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$t_{\text{cal}} =$ Calculated t-Value, $t_{\text{tab}} =$ Tabulated t-Value, $df =$ 223
$p =$ Significance Value, LOS =$ Level of Significance

Table 4.76 reflects the mean values of Academic Achievement of F.D female and F.I female of whole sample. For more clarity, the same data has been presented in the following graph.

Figure 4.76 Mean Plot of Academic Achievement of Field-Dependent female and Field—Independent female with respect to Gender

Hypothesis: There may be no significant difference academic achievement of F.D Female and F.I female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{\text{cal}}$ was greater than $t_{\text{tab}}$ (5.852>1.984, $p=0.000$, $df=223$). Field-Independent female undergraduate science students have more academic achievement than Field-Dependent female. The difference is significant (at 0.05 significance level) between mean values of Academic Achievement of female F.D and female F.I undergraduate science students of whole sample. Hence, the above hypothesis is rejected.
Strata wise Analysis

Table 4.77  
Academic Achievement of Field-Dependent female and Field – Independent female of Basic Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D Female of Basic Sciences Strata</td>
<td>61</td>
<td>2.5756</td>
<td>.7645</td>
<td>-4.303</td>
<td>1.984</td>
<td>0.000</td>
<td>t_{Cal} &gt; t_{Tab}</td>
</tr>
<tr>
<td>Academic Achievement of F.I Female of Basic Sciences Strata</td>
<td>60</td>
<td>3.1325</td>
<td>.6539</td>
<td>4.303</td>
<td>1.984</td>
<td>0.000</td>
<td>4.303 &gt; 1.984</td>
</tr>
</tbody>
</table>

\( t_{Cal} = \) Calculated t-Value, \( t_{Tab} = \) Tabulated t-Value, \( df = 119 \)
\( p = \) Significance Value, \( LOS = \) Level of Significance

Table 4.77 reflects the mean values of Academic Achievement of Field-Dependent female and Field –Independent female of basic Science Strata. For more clarity, the same data has been presented in the following graph.

\[ \text{Figure 4.77 Mean Plot of Academic Achievement of Field-Dependent female and Field –Independent female of Basic Science Strata} \]

\[ \text{H}_{09d}. \text{There may be no significant difference academic achievement of F.D Female and F.I female undergraduate science students} \]

The t-test was implied and it was found that the calculated value of \( t_{Cal} \) was greater than \( t_{Tab} \) (4.303 > 1.984, \( p= 0.000, \) \( df=119 \)). Field-Independent female undergraduate science students have comparatively more academic achievement than Field-Dependent female. This difference is significant (at 0.05 significance level), hence, the above hypothesis is rejected.
Table 4.78  Academic Achievement of Field-Dependent female and Field – Independent female of Computer Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D Female of Computer Science Strata</td>
<td>21</td>
<td>2.9395</td>
<td>.5548</td>
<td>-0.698</td>
<td>2.048</td>
<td>0.491</td>
<td>t_{Cal} &lt; t_{Tab}</td>
</tr>
<tr>
<td>Academic Achievement of F.I Female of Computer Science Strata</td>
<td>9</td>
<td>3.0922</td>
<td>.5341</td>
<td>0.698</td>
<td>&lt;2.048</td>
<td>0.491</td>
<td>p = 0.491, df = 28</td>
</tr>
</tbody>
</table>

$t_{Cal} = $ Calculated t-Value,  $t_{Tab} = $ Tabulated t-Value,  $p = $ Significance Value,  LOS = Level of Significance

Table 4.78 reflects the mean values of Academic Achievement of Field-Dependent female and Field – Independent female of Computer Science Strata. For more clarity, the same data has been presented in the following graph.

\[ \text{Figure 4.78} \quad \text{Mean Plot of Academic Achievement of Field-Dependent female and Field – Independent female of Computer Science Strata} \]

$H_{094a}$. There may be no significant difference academic achievement of F.D Female and F.I female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{Cal}$ was less than $t_{Tab}$ ($0.698 < 2.048, \ p = 0.491, \ df=28$). Although there is difference between mean values of academic achievement of F.D female and F.I female undergraduate science students. Field-Independent female have comparatively more academic achievement than Field-Dependent female. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of female F.D and female F.I of computer science strata. Hence, the above hypothesis is accepted.
Table 4.79  
*Academic Achievement of Field-Dependent female and Field – Independent female of Engineering Science Strata*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of F.D Female of Engr. Sci. Strata</td>
<td>19</td>
<td>2.6732</td>
<td>.6593</td>
<td>-4.100</td>
<td>2.000</td>
<td>0.000</td>
<td>( t_{\text{Cal}} &gt; t_{\text{Tab}} )</td>
</tr>
<tr>
<td>Academic Achievement of F.I Female of Engr.Sci. Strata</td>
<td>55</td>
<td>3.2087</td>
<td>.4199</td>
<td>4.100</td>
<td>2.000</td>
<td>0.000</td>
<td>( 4.100 &gt; 2.000 )</td>
</tr>
</tbody>
</table>

\( t_{\text{Cal}} = \) Calculated t-Value, \( t_{\text{Tab}} = \) Tabulated t-Value, \( df = 72 \)  
\( p = \) Significance Value, \( LOS = \) Level of Significance

Table 4.79 reflects the mean values of Academic Achievement of Field-Dependent female and Field–Independent female of Engineering Science Strata. For more clarity, the same data has been presented in the following graph.

**Figure 4.79**  Mean Plot of Academic Achievement of Field-Dependent female and Field –Independent female of Engineering Science Strata

*H_{09d}. There may be no significant difference academic achievement of F.D Female and F.I female undergraduate science students*

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was less than \( t_{\text{Tab}} \) (4.100> 2.000, \( p= 0.000, df=72 \)). Field-Independent female have comparatively more academic achievement than Field-Dependent female undergraduate science students. There is significant difference (at 0.05 significance level) between mean values of Academic Achievement of Field-Dependent female and Field – Independent female of Engineering Science Strata. Hence, the above hypothesis is rejected.
Section-II

Analysis of Academic Achievement with respect to Convergent/Divergent Cognitive Learning Style

Table 4.80  
<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON</td>
<td>200</td>
<td>2.5038</td>
<td>.75112</td>
<td>-8.040</td>
<td>1.984</td>
<td>0.000</td>
<td></td>
</tr>
<tr>
<td>Academic Achievement of DIV</td>
<td>191</td>
<td>3.0776</td>
<td>.65417</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\( t_{\text{Cal}} \) = Calculated t-Value, \( t_{\text{Tab}} \) = Tabulated t-Value,  
\( df = 389 \)

\( p \) = Significance Value,  
LOS = Level of Significance

Table 4.81 reflects the mean values of Academic Achievement of Convergent and Divergent. For more clarity, the same data has been presented in the following graph.

Figure 4.80  Mean Plot of Academic Achievement of Convergent and Divergent

H\(_0\). There may be no difference between academic achievement of undergraduate science students having Convergent and Divergent cognitive learning style

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was greater than \( t_{\text{Tab}} \) (8.040 > 1.984, \( p = 0.000 \), \( df = 389 \)). Divergent undergraduate science students have comparatively more academic achievement than Convergers. There is significant difference (at 0.05 significance level) between mean values of Academic Achievement of convergent and divergent undergraduate science students of whole sample. Hence, the above hypothesis is rejected.
a. Academic Achievement of male and female with respect to Convergent Cognitive Learning Style

- Whole Sample

Table 4.81: Academic Achievement of Convergent with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON Male</td>
<td>153</td>
<td>2.4443</td>
<td>.75433</td>
<td>-2.037</td>
<td>1.984</td>
<td>0.043</td>
<td>&gt;</td>
</tr>
<tr>
<td>Academic Achievement of CON Female</td>
<td>47</td>
<td>2.6974</td>
<td>.71441</td>
<td></td>
<td></td>
<td></td>
<td>&gt; 1.984</td>
</tr>
</tbody>
</table>

\[ t_{Cal} = \text{Calculated t-Value, } t_{Tab} = \text{Tabulated t-Value, } df = 198 \]

\[ p = \text{Significance Value, } LOS = \text{Level of Significance} \]

Table 4.81 reflects the mean values of Academic Achievement of male and female Convergent. For more clarity, the same data has been presented in the following graph.

\[ Figure \ 4.81 \quad \text{Mean Plot of Academic Achievement of Convergent with respect to Gender} \]

\[ H_{010a}.: \text{There may be no significant difference between academic achievement of CON male and CON female undergraduate science students} \]

The t-test was implied and it was found that the calculated value of \( t_{Cal} \) was greater than \( t_{Tab} \) (2.037 > 1.984, \( p = 0.043 \), \( df=198 \)). The Convergent female undergraduate science students have comparatively more academic achievement than Convergent male. There is significant difference (at 0.05 significance level) between mean values of Academic Achievement of convergent male and female undergraduate science students of whole sample. Hence, the above hypothesis is rejected.
- **Strata wise Analysis**

Table 4.82  *Academic Achievement of Convergent of Basic Science Strata with respect to Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON Male of Basic Sciences Strata</td>
<td>35</td>
<td>2.4171</td>
<td>1.0414</td>
<td>-0.945</td>
<td>2.000</td>
<td>0.348</td>
<td>t_{Cal} &lt; t_{Tab}</td>
</tr>
</tbody>
</table>

Academic Achievement of CON Female of Basic Sciences Strata

31 2.6323 .7660

\[ t_{Cal} = \text{Calculated} \ t\text{-Value} \quad t_{Tab} = \text{Tabulated} \ t\text{-Value}, \quad df = 64 \]
\[ p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance} \]

Table 4.82 reflects the mean values of Academic Achievement of male and female Convergent of basic science strata. For more clarity, the same data has been presented in the following graph.

![Graph showing mean plot of academic achievement with respect to gender](image)

*Figure 4.82  Mean Plot of Academic Achievement of Convergent of Basic Science Strata with respect to Gender*

**H_{010a}. There may be no significant difference between academic achievement of CON male and CON female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{Cal} \) was less than \( t_{Tab} \). Although Convergent female undergraduate science students have comparatively more academic achievement than Convergent male. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male Convergent and female Convergent undergraduate science students of basic science strata. Hence, the above hypothesis is accepted.
Table 4.83  
*Academic Achievement of Convergent of Computer Science Strata with respect to Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t&lt;sub&gt;Cal&lt;/sub&gt;</th>
<th>t&lt;sub&gt;Tab&lt;/sub&gt;</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON Male of Computer Science Strata</td>
<td>40</td>
<td>2.4725</td>
<td>.5208</td>
<td>-2.007</td>
<td>2.021</td>
<td>0.051</td>
<td>&lt;t&lt;sub&gt;Cal&lt;/sub&gt; &lt; t&lt;sub&gt;Tab&lt;/sub&gt;</td>
</tr>
<tr>
<td>Academic Achievement of CON Female of Computer Science Strata</td>
<td>3</td>
<td>3.0833</td>
<td>.1021</td>
<td>2.007</td>
<td>2.021</td>
<td></td>
<td>&lt;t&lt;sub&gt;Cal&lt;/sub&gt; &lt; t&lt;sub&gt;Tab&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

-<sub>Cal</sub> = Calculated t-Value,  
-<sub>Tab</sub> = Tabulated t-Value,  
-<sub>p</sub> = Significance Value,  
-<sub>LOS</sub> = Level of Significance

The table reflects the mean values of Academic Achievement of male and female Convergent of computer science strata. For more clarity, the same data has been presented in the following graph.

**Figure 4.83**  
Mean Plot of Academic Achievement of Convergent of Computer Science Strata with respect to Gender

**H010a. There may be no significant difference between academic achievement of CON male and CON female undergraduate science students**

The t-test was implied and it was found that the calculated value of t<sub>Cal</sub> was less than t<sub>Tab</sub> (2.007 < 1.984, p = 0.051, df = 41). Although Convergent undergraduate science students female have comparatively more academic achievement than Convergent female. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male Convergent and female Convergent undergraduate science students of computer science strata. Hence, the above hypothesis is rejected.
Table 4.84  Academic Achievement of Convergent of Engineering Science Strata
with respect to Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t&lt;sub&gt;Cal&lt;/sub&gt;</th>
<th>t&lt;sub&gt;Tab&lt;/sub&gt;</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON Male of Engineering Science Strata</td>
<td>78</td>
<td>2.4421</td>
<td>.71148</td>
<td>-1.524</td>
<td>1.990</td>
<td>0.131</td>
<td>t&lt;sub&gt;Cal&lt;/sub&gt; &lt; t&lt;sub&gt;Tab&lt;/sub&gt;</td>
</tr>
<tr>
<td>Academic Achievement of CON Female of Engineering Science Strata</td>
<td>13</td>
<td>2.7638</td>
<td>.65945</td>
<td></td>
<td></td>
<td></td>
<td>1.524&lt;1.990</td>
</tr>
</tbody>
</table>

\[ t_{cal} = \text{Calculated } t\text{-Value}, \quad t_{tab} = \text{Tabulated } t\text{-Value}, \quad df = 89 \]
\[ p = \text{Significance Value}, \quad LOS = \text{Level of Significance} \]

Table 4.84 reflects the mean values of Academic Achievement of male and female Convergent of engineering science strata. For more clarity, the same data has been presented in the following graph.

Figure 4.84  Mean Plot of Academic Achievement of Convergent of Engineering Science Strata with respect to Gender

H<sub>010a</sub>. **There may be no significant difference between academic achievement of CON male and CON female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{cal} \) was less than \( t_{tab} \) (1.524 < 1.990, \( p= 0.131, \ df=89 \)). Although Convergent female undergraduate science students have comparatively more academic achievement than Convergent female. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male Convergent and female Convergent of engineering science strata. Hence, the above hypothesis is accepted.
b. Academic Achievement of Male and Female with respect to Divergent Cognitive Learning Style

- Whole Sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>(t_{\text{Cal}})</th>
<th>(t_{\text{Tab}})</th>
<th>(p)</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of Male DIV</td>
<td>59</td>
<td>2.8553</td>
<td>.7954</td>
<td>-3.217</td>
<td>1.984</td>
<td>0.002</td>
<td>(t_{\text{Cal}} &gt; t_{\text{Tab}})</td>
</tr>
<tr>
<td>Academic Achievement of Female DIV Strata</td>
<td>132</td>
<td>3.1770</td>
<td>.5552</td>
<td></td>
<td></td>
<td></td>
<td>3.217&gt;1.984</td>
</tr>
</tbody>
</table>

\(t_{\text{Cal}} = \text{Calculated t-Value}, \quad t_{\text{Tab}} = \text{Tabulated t-Value}, \quad df = 189\)

\(p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance}\)

Table 4.85 reflects the mean values of Academic Achievement of male and female Divergent of whole sample. For more clarity, the same data has been presented in the following graph.

![Figure 4.85 Mean Plot of Academic Achievement of Divergent with respect to Gender](image)

**Figure 4.85** Mean Plot of Academic Achievement of Divergent with respect to Gender

**H_0\text{10b. There may be no significant difference between academic achievement of DIV male and DIV female undergraduate science students}**

The t-test was implied and it was found that the calculated value of \(t_{\text{Cal}}\) was greater than \(t_{\text{Tab}}\) (3.217> 1.984, \(p= 0.002, \quad df=189\)). Divergent female undergraduate science students have comparatively more academic achievement than Divergent male. There is significant difference (at 0.05 significance level) between mean values of Academic Achievement of male Divergent and female Divergent undergraduate science students of whole sample. Hence, the above hypothesis is rejected.
### Strata wise Analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t&lt;sub&gt;cal&lt;/sub&gt;</th>
<th>t&lt;sub&gt;tab&lt;/sub&gt;</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of DIV Male of Basic Science Strata</td>
<td>12</td>
<td>2.6342</td>
<td>1.3364</td>
<td>-2.754</td>
<td>2.000</td>
<td>0.007</td>
<td>&gt; t&lt;sub&gt;tab&lt;/sub&gt;</td>
</tr>
<tr>
<td>Academic Achievement of DIV Female of Basic Science Strata</td>
<td>65</td>
<td>3.2645</td>
<td>0.5612</td>
<td>2.754&gt;2.000</td>
<td>2.000</td>
<td>0.007</td>
<td></td>
</tr>
</tbody>
</table>

\[ t_{\text{cal}} = \text{Calculated } t\text{-Value}, \quad t_{\text{tab}} = \text{Tabulated } t\text{-Value}, \quad df = 75 \]

\[ p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance} \]

Table 4.86 reflects the mean values of Academic Achievement of male and female Divergent of basic science strata. For more clarity, the same data has been presented in the following graph.

![Graph of Academic Achievement of Divergent of Basic Science Strata with respect to Gender](image)

**Figure 4.86** Mean Plot of Academic Achievement of Divergent of Basic Science Strata with respect to Gender

**H010b. There may be no significant difference between academic achievement of DIV male and DIV female undergraduate science students**

The t-test was implied and it was found that the calculated value of \( t_{\text{cal}} \) was greater than \( t_{\text{tab}} \) (2.754>2.000, p=0.007, df=75). Divergent female undergraduate science students have comparatively more academic achievement than Divergent male. There is significant difference (at 0.05 significance level) between mean values of Academic Achievement of male and female Divergent undergraduate science students of basic science strata. Hence, the above hypothesis is rejected.
Table 4.87  *Academic Achievement of Divergent of Computer Science Strata with respect to Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>(t_{Cal})</th>
<th>(t_{Tab})</th>
<th>(p)</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of DIV Male of Computer Science Strata</td>
<td>16</td>
<td>2.7938</td>
<td>.5592</td>
<td>-0.785</td>
<td>2.042</td>
<td>0.438</td>
<td></td>
</tr>
<tr>
<td>Academic Achievement of DIV Female of Computer Science Strata</td>
<td>21</td>
<td>2.9476</td>
<td>.6133</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(t_{Cal} = \) Calculated t-Value, \(t_{Tab} = \) Tabulated t-Value, \(df = 35\)

Table 4.87 reflects the mean values of Academic Achievement of male and female Divergent of computer science strata. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Academic Achievement of Divergent of Computer Science Strata with respect to Gender](image)

**Figure 4.87** Mean Plot of Academic Achievement of Divergent of Computer Science Strata with respect to Gender

**H\(_{010b}\):** *There may be no significant difference between academic achievement of DIV male and DIV female undergraduate science students*

The t-test was implied and it was found that the calculated value of \(t_{Cal}\) was less than \(t_{Tab}\) (0.785 < 2.042, \(p = 0.438, df=35\)). Although Divergent female undergraduate science students have comparatively more academic achievement than Divergent male. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male Divergent male and female Divergent undergraduate science students of Computer Science strata. Hence, the above hypothesis is accepted.
Table 4.88  *Academic Achievement of Divergent of Engineering Science Strata with respect to Gender*

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{Cal}$</th>
<th>$t_{Tab}$</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of DIV Male of Engineering Strata</td>
<td>31</td>
<td>2.9726</td>
<td>.61338</td>
<td>-1.463</td>
<td>2.000</td>
<td>0.148</td>
<td>t_{Cal} &lt; t_{Tab}</td>
</tr>
<tr>
<td>Academic Achievement of DIV Female of Engineering Strata</td>
<td>46</td>
<td>3.1583</td>
<td>.49628</td>
<td>1.463</td>
<td>2.000</td>
<td>0.148</td>
<td>t_{Cal} &lt; t_{Tab}</td>
</tr>
</tbody>
</table>

$t_{Cal}$ = Calculated t-Value, $t_{Tab}$ = Tabulated t-Value, df = 75
$p$ = Significance Value, LOS = Level of Significance

Table 4.88 reflects the mean values of Academic Achievement of male and female Divergent of engineering science Strata. For more clarity, the same data has been presented in the following graph.

*Figure 4.88*  Mean Plot of Academic Achievement of Divergent of Engineering Science Strata with respect to Gender

**H_{010b}. There may be no significant difference between academic achievement of DIV male and DIV female undergraduate science students**

The t-test was implied and it was found that the calculated value of $t_{Cal}$ was less than $t_{Tab}$ (1.463 < 2.000, $p = 0.148$, df=75). Although Divergent female undergraduate science students have comparatively more academic achievement than Divergent male. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male Divergent male and female Divergent undergraduate science students of Engineering Science Strata. Hence, the above hypothesis is accepted.
c. Academic Achievement of Convergent male and Divergent male

- Whole Sample

Table 4.89 Academic Achievement of Convergent male and Divergent male

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t&lt;sub&gt;Cal&lt;/sub&gt;</th>
<th>t&lt;sub&gt;Tab&lt;/sub&gt;</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON Male</td>
<td>153</td>
<td>2.4443</td>
<td>.7543</td>
<td>-3.501</td>
<td>1.984</td>
<td>0.001</td>
<td>t&lt;sub&gt;Cal&lt;/sub&gt; &gt; t&lt;sub&gt;Tab&lt;/sub&gt;</td>
</tr>
<tr>
<td>Academic Achievement of DIV Male</td>
<td>59</td>
<td>2.8553</td>
<td>.7954</td>
<td></td>
<td></td>
<td></td>
<td>3.501&gt;1.984</td>
</tr>
</tbody>
</table>

\[ t_{\text{Cal}} = \text{Calculated t-Value}, \quad t_{\text{Tab}} = \text{Tabulated t-Value}, \quad df = 210 \]

\[ p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance} \]

Table 4.89 reflects the mean values of Academic Achievement of Convergent male and Divergent male of whole sample. For more clarity, the same data has been presented in the following graph.

Figure 4.89 Mean Plot of Academic Achievement of Convergent male and Divergent male

H<sub>0</sub>: there may be no significant difference between academic achievement of CON male and DIV male undergraduate science students

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was greater than \( t_{\text{Tab}} \) (3.501>1.984, \( p=0.001, \quad df=210 \)). Divergent male undergraduate science students have comparatively more academic achievement than Convergent male. There is significant difference (at 0.05 significance level) between mean values of Academic Achievement of male Convergent and male Divergent undergraduate science students of whole sample. Hence, the above hypothesis is rejected.
- **Strata wise Analysis**

Table 4.90  
*Academic Achievement of Convergent male and Divergent male of Basic Science Strata*

<table>
<thead>
<tr>
<th>Variables</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t&lt;sub&gt;cal&lt;/sub&gt;</th>
<th>t&lt;sub&gt;tab&lt;/sub&gt;</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON Male Basic Sciences Strata</td>
<td>35</td>
<td>2.4171</td>
<td>1.0414</td>
<td>-0.579</td>
<td>2.021</td>
<td>0.566</td>
<td>0.579&lt;2.021</td>
</tr>
<tr>
<td>Academic Achievement of DIV Male Basic Sciences Strata</td>
<td>12</td>
<td>2.6342</td>
<td>1.3364</td>
<td>t&lt;sub&gt;cal&lt;/sub&gt;</td>
<td>t&lt;sub&gt;tab&lt;/sub&gt;</td>
<td>df=45</td>
<td></td>
</tr>
</tbody>
</table>

\[ t<sub>cal</sub> = \text{Calculated t-Value}, \quad t<sub>tab</sub> = \text{Tabulated t-Value}, \quad df = 45 \]

\[ p = \text{Significance Value}, \quad \text{LOS} = \text{Level of Significance} \]

Table 4.90 reflects the mean values of Academic Achievement of Convergent male and Divergent male of basic science strata. For more clarity, the same data has been presented in the following graph.

*Figure 4.90*  
Mean Plot of Academic Achievement of Convergent male and Divergent male of Basic Science Strata

**H<sub>0</sub>: There may be no significant difference between academic achievement of CON male and DIV male undergraduate science students**

The t-test was implied and it was found that the calculated value of t<sub>cal</sub> was less than t<sub>tab</sub> (0579 < 2.021, p= 0.566 df=45). Although Divergent males undergraduate science students have comparatively more academic achievement than Convergent male. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male Convergent and male Divergent undergraduate science students of basic science strata. Hence, the above hypothesis is accepted.

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Table 4.91 Academic Achievement of Convergent male and Divergent male of Computer Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t_{Cal}</th>
<th>t_{Tab}</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON Male of Computer Science Strata</td>
<td>40</td>
<td>2.4725</td>
<td>.5208</td>
<td>-2.042</td>
<td>2.021</td>
<td>0.046</td>
<td>t_{Cal} &gt; t_{Tab}</td>
</tr>
<tr>
<td>Academic Achievement of DIV Male of Computer Science Strata</td>
<td>16</td>
<td>2.7938</td>
<td>.5592</td>
<td></td>
<td></td>
<td></td>
<td>t_{Cal} = Calculated t-Value , t_{Tab} = Tabulated t-Value, df = 54</td>
</tr>
</tbody>
</table>

$p$ = Significance Value, LOS = Level of Significance

Table 4.91 reflects the mean values of Academic Achievement of Convergent male and Divergent male. For more clarity, the same data has been presented in the following graph.

Figure 4.91 Mean Plot of Academic Achievement of Convergent male and Divergent male of Computer Science Strata

**H_{010c}. here may be no significant difference between academic achievement of CON male and DIV male undergraduate science students**

The t-test was implied and it was found that the calculated value of $t_{Cal}$ greater than $t_{Tab}$ ($2.042 > 2.021, \ p = 0.046, \ df=54$). The Divergent male undergraduate science students has comparatively more academic achievement than Convergent male. There is difference between mean values of academic achievement of CON male and DIV male undergraduate science students. Hence, the above hypothesis is rejected.
Table 4.92 Academic Achievement of Convergent male and Divergent male of Engineering Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{Cal}$</th>
<th>$t_{Tab}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON Male of Engr. Science Strata</td>
<td>78</td>
<td>2.4421</td>
<td>.7114</td>
<td>-3.646</td>
<td>1.984</td>
<td>0.000</td>
<td>3.646 &gt; 1.984</td>
</tr>
<tr>
<td>Academic Achievement of DIV Male of Engr. Science Strata</td>
<td>31</td>
<td>2.9726</td>
<td>.6133</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$t_{Cal}$ = Calculated $t$-Value, $t_{Tab}$ = Tabulated $t$-Value, $df$ = 107

$p$ = Significance Value, LOS = Level of Significance

Table 4.92 reflects the mean values of Academic Achievement of Convergent male and Divergent male of engineering sciences strata. For more clarity, the same data has been presented in the following graph.

![Mean Plot of Academic Achievement of Convergent male and Divergent male of Engineering Science Strata](image)

$H_{010c}$: There may be no significant difference between academic achievement of CON male and DIV male undergraduate science students

The $t$-test was implied and it was found that the calculated value of $t_{Cal}$ was greater than $t_{Tab}$ (3.646 > 1.984, $p$ = 0.000, $df$=107). Although there is difference between mean values of academic achievement of CON male and DIV male undergraduate science students. The Divergent males undergraduate science students have comparatively more academic achievement than Convergent male. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of male Convergent and male Divergent engineering science strata. Hence, the above hypothesis is rejected.
d. Academic Achievement of Convergent female and Divergent female

• Whole Sample

Table 4.93 Academic Achievement of Convergent female and Divergent female

<table>
<thead>
<tr>
<th>Variable of CON Female</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t&lt;sub&gt;Cal&lt;/sub&gt;</th>
<th>t&lt;sub&gt;Tab&lt;/sub&gt;</th>
<th>p</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement</td>
<td>47</td>
<td>2.697</td>
<td>.7144</td>
<td>-4.701</td>
<td>1.984</td>
<td>0.000</td>
<td>t&lt;sub&gt;Cal&lt;/sub&gt; &gt; t&lt;sub&gt;Tab&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.701 &gt; 1.984</td>
</tr>
<tr>
<td>Academic Achievement</td>
<td>132</td>
<td>3.177</td>
<td>.5552</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Where:
- t<sub>Cal</sub> = Calculated t-Value
- t<sub>Tab</sub> = Tabulated t-Value
- df = 177
- p = Significance Value
- LOS = Level of Significance

Table 4.93 reflects the mean values of Academic Achievement of Convergent female and Divergent female of whole sample. For more clarity, the same data has been presented in the following graph.

Figure 4.93 Mean Plot of Academic Achievement of Convergent female and Divergent female

H<sub>0</sub>10d. There may be no significant difference between academic achievement of CON female and DIV female undergraduate science students

The t-test was implied and it was found that the calculated value of t<sub>Cal</sub> was greater than t<sub>Tab</sub> (4.701 > 1.984, p = 0.000, df = 177). The Divergent female undergraduate science students have comparatively more academic achievement than Convergent female. There is highly significant difference (at 0.05 significance level) between mean values of Academic Achievement of female Convergent and female Divergent undergraduate science students of whole sample. Hence, the above hypothesis is rejected.
Strata wise Analysis

Table 4.94  

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>( t_{\text{Cal}} )</th>
<th>( t_{\text{Tab}} )</th>
<th>( p )</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON Female of Basic Sciences Strata</td>
<td>31</td>
<td>2.6323</td>
<td>.7660</td>
<td>-4.570</td>
<td>1.990</td>
<td>0.000</td>
<td>( t_{\text{Cal}} &gt; t_{\text{Tab}} )</td>
</tr>
<tr>
<td>Academic Achievement of DIV Female of Basic Sciences Strata</td>
<td>65</td>
<td>3.2645</td>
<td>.5612</td>
<td>( t_{\text{Cal}} = \text{Calculated t-Value} )</td>
<td>( t_{\text{Tab}} = \text{Tabulated t-Value} )</td>
<td>( df = 94 )</td>
<td></td>
</tr>
</tbody>
</table>

\[ t_{\text{Cal}} = \text{Calculated t-Value} \]
\[ t_{\text{Tab}} = \text{Tabulated t-Value} \]
\[ df = \text{Degree of Freedom} \]
\[ p = \text{Significance Value} \]
\[ \text{LOS} = \text{Level of Significance} \]

Table 4.94 reflects the mean values of Academic Achievement of Convergent Female and Divergent Female of basic Science Strata. For more clarity, the same data has been presented in the following graph.

![Figure 4.94](image)

**Figure 4.94**  
Mean Plot of Academic Achievement of Convergent Female and Divergent Female of Basic Science Strata

\[ H_{0104} \text{There may be no significant difference between academic achievement of CON female and DIV female undergraduate science students} \]

The t-test was implied and it was found that the calculated value of \( t_{\text{Cal}} \) was greater than \( t_{\text{Tab}} \) (4.570>1.990, \( p = 0.000 \), \( df=94 \)). Divergent female undergraduate science students have comparatively more academic achievement than Convergent female. There is significant difference (at 0.05 significance level) between mean values of Academic Achievement of Convergent female and Divergent female undergraduate science students of basic sciences strata. Hence, the above hypothesis is rejected.
Table 4.95 Academic Achievement of Convergent Female and Divergent Female of Computer Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{Cal}$</th>
<th>$t_{Tab}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON Female of Computer Science Strata</td>
<td>3</td>
<td>3.0833</td>
<td>.10214</td>
<td>0.375</td>
<td>2.074</td>
<td>0.711</td>
<td></td>
</tr>
<tr>
<td>Academic Achievement of DIV Female of Computer Science Strata</td>
<td>21</td>
<td>2.9476</td>
<td>.61336</td>
<td>0.375</td>
<td>2.074</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$t_{Cal} = $ Calculated $t$-Value, $t_{Tab} = $ Tabulated $t$-Value, $df = 22$,
$p = $ Significance Value, $LOS = $ Level of Significance

Table 4.95 reflects the mean values of Academic Achievement of Convergent Female and Divergent Female of Computer Science Strata. For more clarity, the same data has been presented in the following graph.

![Figure 4.95 Mean Plot of Academic Achievement of Convergent Female and Divergent Female of Computer Science Strata](image)

**H$_{010d}$ There may be no significant difference between academic achievement of CON female and DIV female undergraduate science students**

The $t$-test was implied and it was found that the calculated value of $t_{Cal}$ was less than $t_{Tab}$ ($0.375 < 2.074$, $p = 0.711$, $df=22$). Although Divergent female undergraduate science students have comparatively more academic achievement than Convergent female. However, the difference is not significant (at 0.05 significance level) between mean values of Academic Achievement of female Convergent and female Divergent undergraduate science students of computer engineering sciences strata. Hence, the above hypothesis is accepted.
Table 4.96  Academic Achievement of Convergent Female and Divergent Female of Engineering Science Strata

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>$t_{cal}$</th>
<th>$t_{tab}$</th>
<th>$p$</th>
<th>At 0.05 LOS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic Achievement of CON Female of Engineering Science Strata</td>
<td>13</td>
<td>2.7638</td>
<td>.6594</td>
<td>-2.348</td>
<td>2.021</td>
<td>0.022</td>
<td>$t_{cal} &gt; t_{tab}$</td>
</tr>
<tr>
<td>Academic Achievement of DIV Female of Engineering Science Strata</td>
<td>46</td>
<td>3.1583</td>
<td>.4962</td>
<td></td>
<td></td>
<td></td>
<td>$t_{cal} &gt; t_{tab}$</td>
</tr>
</tbody>
</table>

$t_{cal}$ = Calculated t-Value, $t_{tab}$ = Tabulated t-Value, df = 57
$p$ = Significance Value, LOS = Level of Significance

Table 4.96 reflects the mean values of Academic Achievement Convergent Female and Divergent Female of Engineering Science Strata. For more clarity, the same data has been presented in the following graph.

Figure 4.96  Mean Plot of Academic Achievement of Convergent Female and Divergent Female of Engineering Science Strata

$H_{010d}$: There may be no significant difference between academic achievement of CON female and DIV female undergraduate science students

The t-test was implied and it was found that the calculated value of $t_{cal}$ was greater than $t_{tab}$ ($2.348 > 2.021$, $p = 0.022$, $df=57$). The Divergent female undergraduate science students have comparatively more academic achievement than Convergent female. There is significant difference (at 0.05 significance level) between mean values of Academic Achievement of female Convergent and female Divergent undergraduate science students of engineering sciences strata. Hence, the above hypothesis is rejected.
PART-VI

Relationships

In this part, the relationship of Cognitive Learning Styles with science related attitude and academic achievement was found. For the correlation analysis, correlation “Spearman’s Rho” was used. The formula for “Spearman’s Rho” is as follows:

\[ r_s = 1 - \frac{6 \sum d^2}{n(n^2 - 1)} \]

Section-I Relationship of Field-Dependent/Field-Independent Learning Style with Science related Attitude

In this section the relationship of Field-Dependent / Field-Independent cognitive learning styles with science related attitude has been identified.

Table: 4.97 Relationship Between Field-Dependent/Independent Cognitive Learning Style And Science related Attitude

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient of Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field-Dependent /Field-Independent Cognitive Learning Style</td>
<td>0.203</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

Science related attitude

*Correlation is significant at the 0.01 level (2-tailed)

Table 4.97 shows that the correlation between Field-Dependent/Field –Independent cognitive learning style and the science related attitude is 0.203 (p< 0.01). It indicates that the relationship between Field-Dependent/ Field- Independent cognitive learning style and science related attitude is statistically significant of Undergraduate science Students. Therefore, null hypothesis is rejected i-e that there may be no relationship between F.D/F.I and science related attitude and alternate hypothesis is accepted that there is significant relationship between F.D/F.IIND and science related attitude.
Table 4.98  *Relationship Between Convergent/Divergent Cognitive Learning Style and Science related Attitude*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient of Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convergent/Divergent Cognitive learning style</td>
<td>0.309</td>
<td>0.000*</td>
</tr>
<tr>
<td>Science related attitude</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.01 level (2-tailed)

Table 4.98 shows that the correlation between Convergent/ Divergent cognitive learning style and their science related attitude is 0.309 (p< 0.01). It indicates that the relationship between Convergent/ Divergent cognitive learning style and science related attitude is statistically significant among Undergraduate science Students. Therefore, null hypothesis is rejected i-e that there may be no relationship between CON/DIV and science related attitude and alternate hypothesis is accepted that there is significant relationship between CON/DIV and science related attitude.
Section-II Relationship of Field-Dependent/ Field-Independent Learning Style with Academic Achievement

In this section the relationship of Field-Dependent / Field-Independent cognitive learning styles with academic achievement was found. For the correlation analysis, correlation “Spearman’s Rho” was used. The formula for “Spearman’s Rho” is as follows:

\[ r_s = 1 - \frac{6 \left( \sum d^2 \right)}{n (n^2 - 1)} \]

Table: 4.99 Relationship Between Field-Dependent/Field-Independent Cognitive Learning Style And Academic Achievement

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient of Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field-Dependent/Field-Independent Cognitive Learning Style</td>
<td>0.346</td>
<td>0.000*</td>
</tr>
<tr>
<td>Academic Achievement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.01 level (2-tailed)

Table 4.99 shows that the correlation between Field-Dependent/Field-Independent cognitive learning style and academic achievement is 0.346(p< 0.01). It indicates that the relationship between Field-Dependent/Field-Independent cognitive learning style and academic achievement is statistically significant among Undergraduate science Students. Therefore, null hypothesis is rejected i-e that there may be no relationship between F.D/F.I and academic achievement and alternate hypothesis is accepted that there is significant relationship between F.D/F.IIND and academic achievement.
Table 4.100  *Relationship Between Convergent/ Divergent Cognitive Learning Style And Academic Achievement*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient of Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convergent/Divergent Cognitive Learning Style</td>
<td>0.420</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.01 level (2-tailed)*

Table 4.100 shows that the correlation between Convergent/ Divergent cognitive learning style and the academic achievement is 0.420 (p< 0.01). It indicates that the relationship between Convergent/ Divergent cognitive learning style and academic achievement is statistically significant among Undergraduate science Students.
Section-III Relationship of Science related Attitude with Academic Achievement

In this section the relationship of science related attitude with academic achievement was found. For the correlation analysis, correlation “Pearson Correlation” was used. The formula for “Pearson Correlation” is as follows:

\[ r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2][n(\sum y^2) - (\sum y)^2]}} \]

Table: 4.101 Relationship Between Science related Attitude And Academic Achievement

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient of Correlation</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science related attitude</td>
<td>0.146</td>
<td>0.000*</td>
</tr>
<tr>
<td>Academic Achievement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.01 level (2-tailed)

Table 4.101 shows that the correlation between science related attitude and academic achievement is 0.146 (p< 0.01). It indicates that there is weak relationship between science related attitude and academic achievement of Undergraduate science Students. Therefore, null hypothesis is rejected i.e that there may be no relationship between academic achievement and science related attitude and alternate hypothesis is accepted that there is significant relationship between academic achievement and science related attitude.
Discussion

Cognitive learning styles and science related attitude of under graduate science students have been discussed below.

- **Cognitive Learning Styles of Undergraduate Students**

  The first objective of the study was to identify cognitive learning styles of undergraduate science students.

  - **Field-Dependent/Field-Independent Cognitive Learning Style**

    Overall, majority of the science students were found Field-Dependent. This finding is in line with the findings of Muhammad, Daniel, and Abdurrauf (2015). These researchers found most of the students as Field-Dependent. The researcher justified this finding and inferred that this Field-Dependence may be due to the concrete level of cognitive thinking.

    Furthermore, male undergraduate science students were found Field-Dependent whereas, female science students were found Field-Independent. This finding is in line with the findings of Yim’s (2009) study. Yim conducted study on the cognitive learning styles of science students of India. The researcher found that female scored much more than male on GEFT. The female students scored nine percent higher than the male students in science academic stream. This indicated that female students in the science academic stream have the capacity to do analysis than the male students. This might be due to the social-economic developments of the countries or the socio economic status of families. In this era, females are more concerned about their education in order to get better jobs. They travel and reach institutions to get education. It shows that female are independent and they want to be successful in society. As Yim said “the cost to their family to send them to a boarding is high, and therefore, they have pressure to do well” (p.93).
Contrary to this, Li (2011) and Bellard (2001), Bieri (1960), Loader, Edward and Henschen (1982), Waber (1977), Torres and Cano (1995), Healy, Harkinsson and Ray (2010) showed that male are more Field-Independent. Onyekuru(2015) cited Witkin and Goodenough (1980) that cultural stereotypes tended to lead males to be Field-Independent and females, Field-Dependent. Witkin and Goodenough (1980) also found that “liberated” females tended to be more Field-Independent than those who preferred the traditional female roles. In the present study, from the urban areas, females were almost as equal as males (Table 3.8). Besides several similarities and dissimilarities, the question arises of how these irregular findings can be explained. Severiens and Ten Dam (1997) as quoted by Zhang and Sternberg (2001) described that these mixed and even contradictory findings of the relationships between cognitive styles and gender is due to various contexts (e.g., different countries and different subject matters) in which the empirical studies were conducted. Additionally, the mixed results could be due to the varying age levels of the students who responded to the items in the inventory.

Gender differences in styles, like differences in most other human performance and behaviors, have been attributed to two major sources: genetic endowments and environmental factors. Vernon (1972) argued that both genetic and socialization factors are involved in the development of F.D/ F.I. Miller (1997) and Torres and Caño (1995 a,b) also found female as Field-Independent. Similarly Mutlu & Temiz (2013) also found females more field-Independent than males.

In the Field-Dependent (male /Female) category, overall, there was significant difference found between male Field-Dependent and female Field–Dependent cognitive learning style where male undergraduate science students were found significantly Field-Dependent. Similar findings were revealed in the computer science strata and engineering science strata where male were found significantly Field-Dependent. Contrary to this, Hansson, Rydén, Johnson (1986) found female more Field-Dependent than male. However, in the basic Science Strata, no significant difference was found regarding Field-Dependent cognitive learning style between male and female undergraduate science students.
In the Field-Independent (Male/Female) category, overall, although female undergraduate science students found Field-Independent however, the difference was not significant. This finding is in line with Cellar, Durr, and Hassell (1989) as quoted by Schuler, Farr, and Smith (2013) that females provided higher level of accuracy and so found higher Field-Independent.

There is significant difference between male and female Field-Independent cognitive learning styles in the basic Science Strata. Female were found more Field-Independent. This is in line with the findings of Mutlu and Temiz (2013) that female were found more Field-Independent in Physics, Bio, and Mathematics than male. This is because as the inclination of field independence increases, so does the interest in abstract and analytic fields. In the computer science strata, male were found significantly Field-Independent while in Engineering Strata no Significant difference was found between male and female regarding Field-Independent cognitive learning style and both male and female undergraduate science students were found equally field-Independent. In BS Electrical Engineering Sciences, male were found as F.I female were F.I. This is because of the reason that Field-Independent individuals are inclined towards careers (engineering, doctor, biologist, etc.) (Witkin et al., 1977).

Convergent/Divergent Cognitive Learning Style

Overall, majority of the science students were found convergent learners. This is in line with Çakiroğlu’s findings (2014). The researcher found that the prominent learning style of Turkey students were convergers. Kolb also described that most of the science students have convergent learning style. It may be due to the reason that science students usually prefer learning through practical applications, including working with technical works or problems, solving problems, trying to make correct decisions, and preferring to work with technical work or problems.

In the Convergent (Male/Female) category, overall, male undergraduate science students were found Convergent whereas, female science students found
Divergent. Roue (2014) mentioned that divergent thinking is an important characteristic in science and engineering and direct measure of creativity. There are mixed results of studies on divergent thinking and gender. Klausmeier and Wiersma (1964a) revealed that gender has foremost impact on divergent thinking tests and found that girls had higher mean score on divergent thinking as compared to mean score of boys. However, Reese et al. (2001) studied 400 adults of 17 years and above and found insignificant results in establishing an association between divergent thinking and gender. Thomas and Berk (1981) recommended that gender differences were predictive of creativity. Dudek, Strobel, Runco (1993) and Roue (2014) Klausmeier and Wiersma’s (1964b) also found that generally, female obtained higher scores than male divergent on thinking tests. However, Chen et al., (2002) found that boys were more divergent. Bhatti (2013), also found that most of the male science students were convergent whereas, majority of the female were found as divergent. Kuhn and Holling (2009) found female to be more divergent on verbal and figural tasks and also found that older students were more divergent.

Similar to Yim (2009), Linn and Hyde (1989) stated that gender differences are not general but specific to cultural and situational frameworks. It is significant to note that the accuracy of measurements of creativity and the divergent thinking process, even after years of research, is still open to differing opinions. Many critics propose that these tests have nothing in place to account for the many factors that cause variation within a person’s creative production, nor for the variation within and between tests of creativity. They also question whether domain-specific questions impact the measurement of creativity (Brown, 1990). However, in this research, the tests used to measure convergent and divergent thinking were developed by center for science education, Glasgow University. These tests are reliable and valid and have been used in numerous researches for the same.

In the convergent (Male/Female) category, there was significant difference between male and female regarding Convergent cognitive learning style. Overall, in the convergent category, male were found significantly convergent cognitive learning styles. In the basic Science Strata, male were not found significantly
convergent. In computer science strata, male were found significantly convergent. In Engineering Science Strata, male were found significantly more CON (SD).

In the Divergent (Male/Female) category, overall, the female undergraduate science students found significantly Divergent. This may be due to the reason that divergent thinking is associated with creativity and female were found more creative than male counter parts. There was significant difference between male and female regarding divergent cognitive learning styles in the basic science strata. Female students were found divergent. However, no significant difference was found between male and female regarding divergent cognitive learning style of computer science strata and engineering science Strata. Roue (2014) found that there is no difference between girls and boys on the measures of divergent thinking. Dudek et al. (1993) and Artola (2013) found that female scored more on divergent tests as compared to male.

- **Science related Attitude**

  The second objective of the study was to explore science related attitude of science students. Science related attitude have a significance place in the teaching learning of science subjects. Craker (2006) emphasized that the study of attitudes is interesting as science careers are continuously and rapidly growing, furthermore, it is worth examining further how and when students develop their attitudes towards science and what can be done for the improvement of attitudes.

  Overall, male undergraduate science students found having more science related attitude as compared to female. Craker (2006), found that males have more confidence/attitude towards science (subject) than females. It may be due to the reason that females considered science as a male domain more than males did. Similarly, in the present study, there were more male science students in the population than female science students. The same reason may also be applied to the present study.

  However, overall there was no significant difference between the science related attitude of male and female undergraduate science students of the sample of
this study. This finding is in line with Akcay, Yager, Iskander and Turgut (2010) as these researchers also found no significant difference between attitudes towards science of male and female science students. The findings of Najafi, Ebrahimitabass, Dehghani and Rezaei (2012), Jenkins (2006), Simpson and Oliver (1985) also reported that males demonstrated significantly more positive attitudes toward science as compared to females. Similarly, Neathery (1997) found no significant difference between the attitudes toward science and gender.

In the computer science strata, significant difference was found whereas, in the basic science strata no significant difference was found regarding science related attitude. This is contrary to the findings of Schibeci (1984) that males demonstrated more attitude toward physics and females demonstrated more positive toward biology. In the engineering science strata, no significant difference was found. Najafi, et. al (2012) also showed that although there were no large differences existed between male and female about attitude towards science and technology, however, female generally had less average in attitude than male. However, Shashaani and Khalili (2001) surveyed the students' attitudes in relation to parental encouragement, gender, and experience. The findings revealed that females were less interested in computers and less confident as compared to males; males were found more experienced. Moreover, it was found that one semester of computer training to the students improved their attitude towards computers.

- **Academic Achievement**

Keeping in view the conceptual framework of the study, the academic achievement of undergraduate science students was also explored. The findings revealed that overall, there was significant difference between the academic achievement of male and female. The academic achievement of female undergraduate science students was better than academic achievement of male undergraduate science students.

Similar situation was revealed in three strata. Although in the basic science strata, female undergraduate science students found having more academic
achievement than male undergraduate science students. However, the difference was not significant. Whereas, in the computer science strata and engineering strata, female undergraduate science students scored significantly better academic achievement than male undergraduate science students. This finding is in line with Hussain, khan, Latif, Amin and Sibtain, (2011) that female science students exhibited significantly better results than male science students.

Spelke (2005) found that research provides evidence regarding development of mathematical and scientific reasoning from a set of biologically based cognitive capacities that males and females share. These capacities lead men and women to develop equal talent for mathematics and science. Narmadha and Chamundeswari (2013) found that females were significantly better regarding attitude towards learning of Science as compared to the male in all categories of schools. In matriculation and central board schools the female students were better than male in their academic achievement in Science whereas, in state board schools there was no significant difference in their gender.

- **Cognitive learning styles and Science related Attitude**

  The third objective of the study was to find science related attitude of undergraduate science students with respect to cognitive learning styles.

  o **F.D/F.I Cognitive Learning style and Science related Attitude**

    Overall, the mean value of science related attitude of Field–Independent undergraduate science students was found significantly greater than Field-Dependents undergraduate science students. This is in line with previous studies (Nozari and Siamian, 2015). O’Brien and Wilkinson (1992) revealed that both Field-Independent male and female performed better than Field-Dependent in all subjects.

    In the Field-Dependent (M/F) category, overall, the mean value of science related attitude of male students was found greater than science related attitude of female students. However, no significant difference was found in this regard. Similarly, in the basic science strata, computer science strata and engineering
science strata, male Field- Dependents had better mean value of science related attitude, however, no significant difference was found regarding it.

In the Field –Independent (M/F) category, overall, the mean value of science related attitude of male F.I was greater than female F.I, however, no significant difference was found regarding it. In the basic science strata, computer science strata and engineering science strata, male have more science related attitude (no significant difference) than female undergraduate science students.

In the F.D/F.I (Male) category, male F.I had more science related attitude (significant difference) than F.D male science students. In the basic science strata and engineering science strata, male F.I had more science related attitude (no Significant difference) than F.D male science students. In computer science strata, F.I male had more science related attitude (significant difference) as compared to F.D male science students.

In F.D/F.I(Female) category, female F.I science students had significantly more science related attitude than F.D female science students. In the basic science strata and engineering science strata, F.I had significantly more science related attitude than F.D female science students. Whereas, in computer science strata, there was no significant difference regarding science related attitude mean of F.D female and F.I female. This finding is in line with Altun and Cakan (2006) that attitude towards computers was found to function independently from cognitive styles.

**o Convergent/Divergent Cognitive Learning Style and Science related Attitude**

Overall divergent learners have significantly more academic achievement than convergent learners. Peker (2009), found significant differences between divergent learners and convergent learners’ attitude in mathematics. It was revealed that this difference was for convergent learners.

In the convergent (M/F) category, male convergent had more science related attitude than female, however, no significant difference was found. In basic science
strata and computer science strata, male convergent have more science related attitude although no significant difference was found. However, in engineering science strata, female convergent have more science related attitude although no significant difference was found than male convergent science undergraduate science students. In divergent (M/F) category, overall, male divergent had more science related attitude although no significant difference was found than female divergent science students.

In basic science strata, female divergent had more science related attitude (no significant difference) than female divergent. In computer science strata and engineering science strata, male divergent had more science related attitude (no significant difference) than female divergent.

Overall, male divergent undergraduate science students had significantly more science related attitude than male convergent undergraduate science students.

In basic Science strata, divergent male undergraduate science students had more (no significant difference) science related attitude than convergent male science students. However, in computer science strata and in engineering science strata, male divergent had significantly more science related attitude than convergent male undergraduate science students.

Overall, divergent female science students have more science related attitude (Significant difference) than convergent female science students.

In basic Science Strata, divergent female have more (Significant Difference), science related attitude than convergent female. However, in the Computer science strata, female divergent have more science related attitude (no Significant Difference) than convergent female science students.

- **Cognitive Learning style and Academic Achievement**

  Keeping in view the conceptual framework of the study, after exploring science related attitude w.r.t cognitive learning styles, the academic achievement of
undergraduate science students w.r.t cognitive learning style was also explored. The comparison of academic achievement of undergraduate science students of different cognitive learning styles was also analyzed. The comparison was done with reference to overall academic achievement in the three strata.

**o F.D/F.I Cognitive Learning style and Academic Achievement**

Field-Independents had significantly more academic achievement than Field-Dependents. Okwo and Otubah (2007), Tinajero, Lemos, Araújo, Ferraces and Páramo (2012) also found that Field-Dependent students scored lower results than Field-Independent class fellows. The same trend has been found in different educational levels and has been verified with different samples of several cultures (Cano, 2006; Danili & Reid, 2004, 2006; Garton, Ball and Dyer, 2002; Tinajero & Páramo, 1997, 1998; Tsaparlis, 2005; Zhang & Sternberg, 2005). It may be due to the reason that Field-Dependent/Field-Independent characteristic correlated with student’s performance in all formats of assessment (although not always significantly). Danili and Reid (2006) argued that being Field-Independent appears to be a very significant factor which effects whether students perform well in almost all types of assessments, and irrespective of the content of the questions. Moreover, as problem solving is significant ability for teaching and learning science. Therefore, Field-Independent students are better in solving the problems as compared to Field-Dependent students. O’Brien and Wilkinson (1992) revealed that both Field-Independent boys and girls performed better than Field-Dependent ones on all subjects. This finding is similar to those of Okwo and Otubah (2007) and Adeyemi (1992) who found that Field-Independent students performed significantly better than Field-Dependent students in physics and biology respectively. Oneykuru (2015) found that the performance of Field-Independent students was significantly better than Field-Dependent students because Field-Independent students are better problem solvers than the Field-Dependent students and problem-solving ability is a crucial factor in teaching and learning of science.
In the Field-Dependent category, there was no significant difference between academic achievement of female Field-Dependent and male Field–Dependent undergraduate science students of the whole sample, basic science strata and engineering science strata. While in computer science strata, female Field-Dependents had significantly more academic achievement than F.D male undergraduate science students.

In the field-Independent category, overall female Field-Independents had significantly more academic achievement than male F.I science students. Hansen (1995), found that in postsecondary technology programme Field-Independent subjects achieved significantly higher mean grades than their Field-Dependent counterparts. Whereas, Yim (2009)’s study revealed no significant difference between academic achievement of male and female Field-Independents.

Comparing academic achievement of Field-Dependent male and Field–Independent male, overall, Field-Independent male have significantly more academic achievement than Field–Dependent male. In Engineering science strata, F.I male had significantly more academic achievement than F.D male. In electrical engineering and computer engineering programmes, F.I had significantly more academic achievement than F.D male undergraduate science students.

Similarly while comparing academic achievement of Field-Dependent female with academic achievement of Field-Independent female, overall Field-Independent female has significantly more academic achievement than Field-Dependent female undergraduate science students.

In basic sciences strata and engineering sciences strata, female F.I had significantly more academic achievement than F.D female. Mutlu and Tamiz (2013), found that some researchers have compared the academic achievement of Field-Dependent and Field-Independent students in various science courses. Generally, the findings of these studies revealed that in some courses containing mathematics and science the Field-Independent students were more successful than Field-Dependent students (Horzum and Alper, 2006; Karaçam and Ateş, 2010). This
finding is valid for both F.I male and F.I female undergraduate science students of this study.

○ Convergent/Divergent Cognitive Learning Style and Academic Achievement

In the Convergent/Divergent category, overall Divergent learners had significantly more academic achievement than convergent learners. Although divergers were less in number, however, divergers achieve higher scores. This finding is in line with Karademir and Tezel (2010), as the researchers found Turkish university students having accommodating and diverging cognitive learning style. Çakıroğlu et al. (2012) found that divergers had higher average scores and learn better through feeling and watching. It may be due to reason that divergers watch and observe. The findings are also similar to Daniel’s (1999) findings that divergers preferred reflective observation (watching), and achieved significantly higher scores. It is due the characteristics of divergers that they “learn when allowed to observe and gather a wide range of information” (Manochehr, 2006). Danili and Reid (2006) found that in assessments that require students to have linguistic skills in order to interpret and elaborate a given text or to explain phenomena, ideas and concepts, or to describe differences, the convergent/divergent style is an important factor for students to perform well.

In Convergent (Male/Female) category, overall, convergent female had significantly more academic achievement than male convergent.

In the divergent (Male/Female) category, overall female divergent had significantly more academic achievement than male divergent science students. In basic science strata, female divergent had significantly more academic achievement than male divergent science students.

In the Convergent/Divergent (male) category, overall, divergent male had significantly more academic achievement than convergent male. In computer science strata and engineering science strata, divergent male undergraduate science students
had significantly more academic achievement than convergent male undergraduate science students.

In the Convergent/ Divergent (Female) category, overall, female divergent had significantly more academic achievement than convergent female. In basic science strata and engineering science strata, female divergent had significantly more academic achievement than convergent female. In computer science strata, convergent female had significantly more academic achievement than divergent female.

**Relationships**

The fourth objective of the study was to find relationship between cognitive learning styles and science related attitude of science students.

There exists positive relationship between Field-Dependent/Field-Independent cognitive learning style and science related attitude is statistically significant of undergraduate science Students. The researchers found that, there was no significant relationship between F.D/F.I cognitive styles and attitude toward computers. Similarly, there exists positive relationship between Convergent/ Divergent cognitive learning style and science related attitude is statistically significant among Undergraduate science Students. It is contrary to the findings of Altun and Cakan (2006). The findings revealed that students' attitudes toward computers are not associated with Field-Dependency, even when their achievement levels were controlled. Attitude toward computers is found to function independently from cognitive styles.

The fifth objective of the study was to find relationship between cognitive learning styles and academic achievement of science students.

In this study, the statistically significant relationship had been found between Field-Dependent//Field-Independent cognitive learning style and academic achievement of undergraduate science Students. This finding is in contradiction with
the findings of Altun and Cakan (2006) that, there was no significant relationship between F.D/F.I cognitive styles and academic achievement (r=.14, p=.15).

In this study, there exists significantly positive relationship between Convergent/ Divergent cognitive learning style and academic achievement of undergraduate science students.

The sixth objective of the study was to find relationship science related attitude and academic achievement.

There existed weak relationship between science related attitude and academic achievement of undergraduate science students. Neathery(1997) found that with multiple correlation, attitude towards science correlated with science achievement. Narmadha and Chamundeshwari (2013) found a positive correlation between attitude towards learning science and academic achievement in science. However, most of the research regarding attitude toward science and its relationship to science achievement showed low positive correlations (Germann, 1998; Keeves & Morganstern, 1992; Schibeci & Riley, 1986). Benhow and Minor (1986) found that mathematically talented male and female students, incline to have favorable attitude towards science and to participate in the sciences at a level much higher than average. There were no overall gender differences in course-taking or course-grades in sciences. Indications of gender differences favoring males, however, were found in participation in high school physics, the taking of and performance on high school and college level science achievement tests and intention to major in the more quantitatively oriented fields of physics and engineering. No substantial gender differences in science related attitude towards the sciences, except possibly physics, were detected. Overall attitude toward science correlated to some extent to participation in science. Moreover, gender differences in mathematical reasoning ability may explain some of the gender difference in science participation and achievement. These results may bear on why female are under-represented in the sciences. Narmadha and Chamundeswari (2013) found a positive correlation existed between attitude towards learning science and science academic achievement of the students.
CHAPTER 5

SUMMARY, FINDINGS, CONCLUSION, AND RECOMMENDATIONS

5.1 Summary

The present study was conducted to understand the cognitive learning styles (Field – Dependent/Field-Independent and Convergent/Divergent) and science related attitude of undergraduate science students. Moreover, in this study academic achievement of the undergraduate science students was also explored. The sample consisted of undergraduate science students of public sector universities/degree awarding institutes (DAIs) of Islamabad. The sample was selected through stratified random sampling and divided into three strata i-e basic sciences strata (including BS Physics, BS Mathematics, and BS Bio Sciences), computer sciences strata (BS Computer Sciences), and engineering sciences strata (BS Electrical Engineering, BS Computer Engineering). Keeping in view the objectives of the study, the data was collected through Convergent-Divergent tests, Field-Dependent/Field-Independent test (SHAPES), science related attitude questionnaire developed by researcher and results of academic achievement of students. The students were found as convergent/Divergent and Field-Dependent/Field-Independent on the basis of scores in the tests. The data was analyzed and hypotheses were tested at 95% confidence level i-e 0.05 level of significance by using SPSS-16. Chi Square, t-test, Pearson Correlation and Spearman’s Rho were used to analyzed the data. The data was presented in tabular as well as graphical form. The results revealed that the divergent and field-Independents had significantly better science related attitude than convergent and Field-Dependents. Moreover, the academic achievements of divergent and Field-Independents was better than convergent and Field-Dependents.
The results also revealed that there exists relationship between cognitive learning style of students and science related attitude. Similarly relationship was also found between cognitive learning styles and academic achievement. In this chapter, the findings, conclusion, and recommendations have been presented.

5.2 Findings
The findings of the study have been presented in the following parts.

Part-I Cognitive Learning Styles
1. Overall, there were 310 undergraduate science students found as Field-Dependent whereas, 221 undergraduate science students were found Field-Independents. (Table 4.1)
2. There were 209 undergraduate male science students found as Field-Dependent and 124 undergraduate science female students were identified as Field-Independent. (Table 4.2)
3. In the whole sample, majority of the male undergraduate science students were found Field-Dependent than female undergraduate science students (Table 4.3)
4. In the basic science strata, no significant difference was found regarding Field-Dependent cognitive learning styles w.r.t gender. (Table 4.4)
5. In the computer science start, significant difference was found regarding Field-Dependent cognitive learning styles w.r.t gender. (Table 4.5)
6. In the engineering science strata, significant difference was found regarding Field-Dependent cognitive learning styles w.r.t gender. (Table 4.6)
7. Overall, no significant difference was found regarding Field-Independent learning styles w.r.t gender. (Table 4.7)
8. In the basic science strata, female undergraduate science students were found significantly Field-Independent than male undergraduate science students. (Table 4.8)
9. In the computer science strata, male undergraduate science students were significant found Field-Independent than female undergraduate science students. (Table 4.9)

10. In the engineering science strata, no significant difference was found regarding Field-Independent learning styles w.r.t gender. (Table 4.10)

11. There were 200 undergraduate science students were found as Convergent, whereas, 191 undergraduate science students were found as Divergent. (Table 4.11)

12. Overall male undergraduate science students were found convergent, while female undergraduate science students found Divergent. (Table 4.12)

13. Overall, significant difference was found regarding convergent learning styles w.r.t gender. Male undergraduate science students were found more convergent. (Table 4.13)

14. In the basic science strata, no significant difference was found between male and female undergraduate science students w.r.t convergent learning styles. (Table 4.14)

15. In the computer science strata, significant difference was found regarding convergent learning styles where male undergraduate science students were found significantly Convergent than female undergraduate science students. (Table 4.15)

16. In the engineering science strata, significant difference was found regarding convergent learning styles where male undergraduate science students were found Convergent. (Table 4.16)

17. Overall, significant difference was found between Divergent learning styles w.r.t gender. Female undergraduate science students were found significantly Divergent. (Table 4.17)

18. In the basic science strata, highly significant difference was found regarding Divergent learning w.r.t gender where female undergraduate science students were found Divergent than male undergraduate science students. (Table 4.18)

19. In the computer science strata, no significant difference was found regarding Divergent learning styles w.r.t gender. (Table 4.19)
20. In the engineering science strata, no significant difference was found regarding Divergent learning styles w.r.t gender. (Table 4.20)

Part-II Science related Attitude
21. Overall, there is no significant difference was found between undergraduate science students regarding science related attitude. (Table 4.21)
22. In the basic science strata, no significant difference was found between male and female undergraduate science students regarding science related attitude. (Table 4.22)
23. In the computer science strata, significant difference was found between male and female undergraduate science students regarding science related attitude. (Table 4.23)
24. In the engineering science strata, no significant difference was found between male and female undergraduate science students regarding science related attitude. (Table 4.24)

Part-III Analyses of Academic Achievement
25. Overall, significant difference was found between male and female undergraduate science students regarding academic achievement. (Table 4.25)
26. In the basic science strata, no significant difference was found between male and female undergraduate science students regarding academic achievement. (Table 4.26)
27. In the computer science strata, significant difference was found between male and female undergraduate science students regarding academic achievement. (Table 4.27)
28. In the engineering science strata, significant difference was found between male and female undergraduate science students regarding academic achievement. (Table 4.28)

Part-IV Science related Attitude w.r.t Cognitive Learning Style
29. Overall, there is highly significant difference was found between science related attitude of Field-Dependents and Field-Independent. (Table 4.29)
30. Overall, there is no significant difference found between science related attitude of male and female undergraduate science students having Field-Dependents. (Table 4.30)

31. In the basic science strata, no significant difference was found between science related attitude of male and female undergraduate science students having Field-Dependents. (Table 4.31)

32. In the computer science strata, no significant difference was found between science related attitude responses of male and female undergraduate science students having Field-Dependents. (Table 4.32)

33. In the engineering science strata, no significant difference was found between science related attitude of male and female undergraduate science students having Field-Dependents. (Table 4.33)

34. Overall, no significant difference was found between science related attitude of male and female undergraduate science students having Field-Independents. (Table 4.34)

35. In the basic science strata, no significant difference was found between science related attitude of male and female undergraduate science students having Field-Independents. (Table 4.35)

36. In the computer science strata, no significant difference was found between science related attitude of male and female undergraduate science students having Field-Independent cognitive learning style. (Table 4.36)

37. In the engineering science strata, no significant difference was found between science related attitude of male and female undergraduate science students having Field-Independent cognitive learning style. (Table 4.37)

38. Overall, significant difference was found between science related attitude of Field-Dependent male and Field-Independents male undergraduate science students. (Table 4.38)

39. In the basic science strata, no significant difference was found between science related attitude of Field-Dependent male and Field-Independents male undergraduate science students. (Table 4.39)
40. In the computer science strata, no significant difference was found between science related attitude of Field-Dependent male and Field-Independents male undergraduate science students. (Table 4.40)

41. In the engineering science strata, no significant difference was found between mean values of science related attitude of Field-Dependent male and Field-Independents male undergraduate science students. (Table 4.41)

42. Overall, significant difference was found between science related attitude Field-Dependent female and Field-Independent female undergraduate science students. (Table 4.42)

43. In the basic science strata, significant difference was found between science related attitude of Field-Dependent female and Field-Independent female undergraduate science students. (Table 4.43)

44. In the computer science strata, no significant difference was found between science related attitude of Field-Dependent female and Field-Independent female undergraduate science students. (Table 4.44)

45. In the engineering science strata, significant difference was found between science related attitude responses of Field-Dependent female and Field-Independent female undergraduate science students. (Table 4.45)

46. Overall, highly significant difference was found between science related attitude Convergent and Divergent undergraduate science students. (Table 4.46)

47. Overall, no significant difference was found between science related attitude of Convergent male and female undergraduate science students. (Table 4.47)

48. In the basic science strata, no significant difference was found between science related attitude of male and female Convergent undergraduate science students. (Table 4.48)

49. In the computer science strata, no significant difference was found between science related attitude of male and female Convergent undergraduate science students. (Table 4.49)
50. In the engineering science strata, no significant difference was found between science related attitude of male and female Convergent undergraduate science students. (Table 4.50)

51. Overall, no significant difference was found between science related attitude of male and female divergent undergraduate science students. (Table 4.51)

52. In the basic science strata, no significant difference was found between science related attitude of male and female undergraduate science students having Divergent cognitive learning style. (Table 4.52)

53. In the computer science strata, no significant difference was found between science related attitude of male and female undergraduate science students having Divergent cognitive learning style. (Table 4.53)

54. In the engineering science strata, no significant difference was found between science related attitude of male and female undergraduate science students having Divergent learning style. (Table 4.54)

55. Overall, significant difference was found between science related attitude of Convergent male and Divergent male undergraduate science students. (Table 4.55)

56. In the basic science strata, no significant difference was found between science related attitude of Convergent male and Divergent male undergraduate science students. (Table 4.56)

57. In the computer science strata, significant difference was found between science related attitude of Convergent male and Divergent male undergraduate science students. (Table 4.57)

58. In the engineering science strata, significant difference was found between science related attitude of Convergent male and Divergent male undergraduate science students. (Table 4.58)

59. Overall, significant difference was found between science related attitude of Convergent female and Divergent female undergraduate science students. (Table 4.59)
60. In the basic science strata, significant difference was found between science related attitude of Convergent female and Divergent female undergraduate science students. (Table 4.60)

61. In the computer science strata, no significant difference was found between science related attitude of Convergent female and Divergent female undergraduate science students. (Table 4.61)

62. In the engineering science strata, no significant difference was found between science related attitude responses of Convergent female and Divergent female undergraduate science students. (Table 4.62)

Part-IV Cognition and Academic Achievement

63. Overall, there is highly significant difference was found between academic achievement of undergraduate science students having Field-Dependent and Field-Independent cognitive learning style. (Table 4.63)

64. In the whole sample, no significant difference was found between academic achievement of male and female undergraduate science students having Field-Dependent cognitive learning style. (Table 4.64)

65. In the basic science strata, no significant difference was found between academic achievement of male and female undergraduate science students having Field-Dependent cognitive learning style. (Table 4.65)

66. In the computer science strata, no significant difference was found between academic achievement of male and female undergraduate science students having Field-Dependent cognitive learning style. (Table 4.66)

67. In the engineering science strata, no significant difference was found between academic achievement of Field-Dependent male and female undergraduate science students. (Table 4.67)

68. In the whole sample, no significant difference was found between academic achievement of Field-Independent male and female undergraduate science students. (Table 4.68)

69. In the basic Science Strata, no significant difference was found between academic achievement of Field-Independent male and female undergraduate science students. (Table 4.69)
70. In the computer science strata, no significant difference was found between academic achievement of Field-Independent male and female undergraduate science students. (Table 4.70)

71. In the engineering science strata, no significant difference was found between academic achievement of Field-Independent male and female undergraduate science students. (Table 4.71)

72. Overall, significant difference was found between academic achievement of Field-Dependent male and Field-Independent undergraduate science students. (Table 4.72)

73. In the basic science strata, significant difference was found between academic achievement of Field-Dependent male and Field-Independent male undergraduate science students. (Table 4.73)

74. In the computer science strata, no significant difference was found between academic achievement of Field-Dependent male and Field-Independent male undergraduate science students. (Table 4.74)

75. In the engineering science strata, significant difference was found between academic achievement of Field-Dependent male and Field-Independent male undergraduate science students. (Table 4.75)

76. Overall, significant difference was found between academic achievement of Field-Dependent female and Field-Independent female undergraduate science students. (Table 4.76)

77. In the basic science strata, significant difference was found between academic achievement of Field-Dependent female and Field-Independent female undergraduate science students. (Table 4.77)

78. In the computer science strata, no significant difference was found between academic achievement of Field-Dependent female and Field-Independent female undergraduate science students. (Table 4.78)

79. In the engineering science strata, significant difference was found between mean values of academic achievement of Field-Dependent female and Field-Independent female undergraduate science students. (Table 4.79)
80. Overall, highly significant difference was found between academic achievement of undergraduate science students having Convergent and Divergent cognitive learning style. (Table 4.80)

81. In the whole sample, significant difference was found between mean values of academic achievement of Convergent male and female undergraduate science students. (Table 4.81)

82. In the basic science strata, no significant difference was found between academic achievement of male and female undergraduate science students having Convergent cognitive learning style. (Table 4.82)

83. In the computer science strata, no significant difference was found between academic achievement of male and female undergraduate science students having Convergent cognitive learning style. (Table 4.83)

84. In the engineering science strata, no significant difference was found between academic achievement of male and female undergraduate science students having Convergent cognitive learning style. (Table 4.84)

85. In the whole sample, significant difference was found between academic achievement of male and female undergraduate science students having convergent cognitive learning style. (Table 4.85)

86. In the basic science strata, significant difference was found between academic achievement of male and female undergraduate science students having Divergent cognitive learning style. (Table 4.86)

87. In the computer science strata, no significant difference was found between academic achievement of male and female undergraduate science students having Divergent cognitive learning style. (Table 4.87)

88. In the engineering science strata, no significant difference was found between academic achievement of male and female undergraduate science students having Divergent cognitive learning style. (Table 4.88)

89. In the whole sample, significant difference was found between academic achievement of Convergent male and Divergent male undergraduate science students. (Table 4.89)
90. In the basic science strata, no significant difference was found between mean values of academic achievement of Convergent male and Divergent male undergraduate science students. (Table 4.90)

91. In the computer science strata, significant difference was found between mean values of academic achievement of Convergent male and Divergent male undergraduate science students. Table 4.91

92. In the engineering science strata, significant difference was found between mean values of academic achievement of Convergent male and Divergent male undergraduate science students. (Table 4.92)

93. In the whole sample, significant difference was found between mean values of academic achievement of Convergent female and Divergent female undergraduate science students. (Table 4.93)

94. In the basic sciences strata, significant difference was found between mean values of academic achievement of Convergent female and Divergent female undergraduate science students. (Table 4.94)

95. In the computer engineering sciences strata, no significant difference was found between mean values of academic achievement of Convergent female and Divergent female undergraduate science students. (Table 4.95)

96. In the engineering sciences strata, significant difference was found between mean values of academic achievement of Convergent female and Divergent female undergraduate science students. (Table 4.96)

Part-VI Relationship

97. There is statistically significant relationship found between Field-Dependent/Field-Independent and science related attitude of undergraduate science Students.(Table 4.97)

98. There is statistically significant relationship found between Convergent/Divergent and science related attitude of undergraduate science Students.(Table 4.98)

99. There is statistically significant relationship found between Field-Dependent/Field-Independent and academic achievement of undergraduate science students.(Table 4.99)
100. There is statistically significant relationship found between Convergent/ Divergent and academic achievement of undergraduate science Students.(Table 4.100)

101. There is significant relationship found between academic achievement and science related attitude. (Table 4.101)

5.2 Conclusion
The following conclusions have been drawn from the findings of the study:

5.2 Cognitive Leaning Styles
Four kinds of cognitive learning styles were explored in this study. As explained in chapter three, the whole sample consisted of male and female undergraduate science students therefore, every cognitive learning style was explored in detail with respect to gender.

5.2.1 Field-Dependent/Field-Independent Cognitive Learning Style

It is concluded that overall, Field-Dependent learning style was the prominent learning style than Field-Independent learning style of undergraduate science students. In the Field–Dependent cognitive learning style category, male science students were significantly Field-Dependents than female science students of the whole sample. Within the strata, male science students of Computer science strata and Engineering science strata were also significantly Field-Dependent than female science students. In the Field–Independent cognitive learning style category, there was significant difference between male field-Independents and female–Independents of basic science strata and computer science strata. Female science students of basic science strata were found significantly Field-Independent while male science students were found significantly field-Independent in the Computer science strata.

5.2.2 Convergent/Divergent Cognitive Learning Style

It is concluded that overall, Convergent learning style was the prominent learning style than divergent learning style of undergraduate science students. In the
Convergent cognitive style category, male science students were found significantly convergent in the whole sample. Within the strata, male science students of Computer science strata and Engineering science strata were also significantly Convergent than female science students. Overall, in the Divergent cognitive learning style category, female science students were significantly Divergent than male science students. Within strata, there was significant difference found between male Divergent and female–Divergent of basic science strata. Female undergraduate science students of basic Science strata were found significantly Divergent.

### 5.2.3 Science related Attitude

It is concluded that although there was no significant difference regarding science related attitude between male and female undergraduate science students in the whole sample, however, male science students showed comparatively better science related attitude than female undergraduate science students. There was significant difference found regarding science related attitude between male and female undergraduate science students of Computer science strata.

### 5.2.4 Academic Achievement

It is concluded that the academic achievement of undergraduate female science students was significantly better than male science students. In this way, female scored significantly better academic achievement than male science students. Similarly in computer science strata and engineering science strata, there existed significant difference between academic achievement of male and female undergraduate science students. Where female undergraduate science students showed better academic achievement than male undergraduate science students.

### 5.2.5 Science related Attitude with respect of Cognitive Learning styles

#### 5.2.5.1 Science related Attitude with respect to Field-Dependent/Field-Independent Cognitive Learning Style

It is concluded that overall, Field-Independent undergraduate science students possessed significantly better science related attitude than Field-Dependent
undergraduate science students. In the Field-Dependent and Field-Independent category, no significant difference was found regarding science related attitude between male and female undergraduate science students. While comparing science related attitude of male Field-Dependent and male Field-Independent undergraduate science students, it was revealed that Field-Independent male undergraduate science students showed significantly better science related attitude than Field-Dependent male undergraduate science students in the whole sample, basic science strata (at 0.01 significance level) and computer science strata.

While comparing science related attitude of female Field-Dependents and female Field-Independents undergraduate science students, it was revealed that Field-Independent female science students showed significantly better science related attitude than Field-Dependent female in the whole sample, basic science and Engineering science strata. It is concluded that mostly Field-Independent male undergraduate science students and Field-Independent female undergraduate science students showed better science related attitude than Field-Dependent male undergraduate science students and Field- Dependent female undergraduate science students.

5.2.5.2 Science related Attitude with respect to Convergent/Divergent Cognitive Learning Style

It is also concluded that overall, significant difference existed regarding science related attitude of Convergent undergraduate science students and Divergent undergraduate science students where Divergent undergraduate science students showed significantly better science related attitude than Convergent undergraduate science students. In the Convergent and Divergent cognitive learning style category, no significant difference was found between male and female undergraduate science students in basic science, computer science, and engineering science strata. While comparing science related attitude of male convergent and male Divergent undergraduate science students, it was revealed that Divergent male science students possessed significantly better science related attitude than Convergent male
undergraduate science students of the whole sample, basic science strata (at 0.01 significance level), computer science strata and engineering science strata. While comparing science related attitude of female convergent and female Divergent undergraduate science students, it was revealed that Divergent female science students showed significantly better science related attitude than Convergent female science students of the whole sample and basic science strata, It is concluded that mostly Divergent male and Divergent female have better science related attitude than convergent male and convergent female.

5.2.6. Academic Achievement with respect to Cognitive Learning Style

5.2.6.1 Academic Achievement with respect to Field-Dependent/Field-Independent Cognitive Learning Style

It is concluded that overall, Field-Independent undergraduate science students scored significantly better academic achievements than Field-Dependent undergraduate science students. In the Field-Dependent cognitive learning style category, no significant difference was found regarding academic achievement of male and female undergraduate science students in the whole sample, basic science strata, and engineering science strata. Whereas, significant difference existed regarding academic achievement of male Field-Dependents and Female Field-Dependents of computer science strata. Similarly, in the Field-Independent category, significant difference was revealed between male and female undergraduate science students of whole sample regarding academic achievement. While no significant difference found regarding academic achievement of male and female undergraduate science students of basic science, Computer science and Engineering science strata.

While comparing academic achievement of male Field-Dependents and male Field-Independents undergraduate science students, it was revealed that Field-Independent male science students showed significantly better academic achievement than Field-Dependent male in the whole sample and engineering science strata. Moreover, no significant difference was revealed regarding academic achievement of Field–Dependents and Field-Independents of basic science strata and computer science strata. While comparing academic achievement of female Field-Dependents and female Field-Independents undergraduate science students, it was revealed that
Field-Independent female science students showed significantly better academic achievement than Field-Dependent female in the whole sample, basic science and engineering science strata.

5.2.6.2 Academic Achievement with respect to Convergent/Divergent Cognitive Learning Style

It is also concluded that overall, there existed significant difference regarding academic achievement between Convergent undergraduate science students and Divergent science students where Divergent undergraduate science students showed significantly better academic achievement than Convergent undergraduate science students. In the Convergent cognitive learning style category, significant difference existed between male and female undergraduate science students of the whole sample where female science students scored significantly better academic achievement than male science students. Similarly, in the Divergent cognitive learning style category, significant difference was revealed between male and female undergraduate science students in the whole sample and basic science strata. However, no significant difference was seen regarding academic achievement in the computer science strata. While comparing academic achievement of male convergent and male Divergent undergraduate science students, it was revealed that Divergent male science students showed significantly better academic achievement than Convergent male undergraduate science students in the whole sample, basic science strata and engineering science strata. However, no significant difference was revealed regarding male and female Divergent science students of computer science strata. While comparing academic achievement of female convergent and female Divergent undergraduate science students, it was revealed that Divergent female science students showed significantly better academic achievement than Convergent female science students of the whole sample, basic science and engineering science strata.

Finally, it is concluded that the academic achievement of Field-Independent was better than Field-Dependents. Similarly the academic achievement of Divergers was better than Convergent. As the most preferred cognitive learning style of female undergraduate science students was found Field-Independent and
Divergent therefore, most of the field-independent and divergent female undergraduate science students scored better grades than field-dependents and convergent.

5.2.7 Relationships

It is concluded that there exists positive relationship between Field-Dependent/Field-Independent cognitive learning style and science related attitude. Similarly, there exists positive relationship between Convergent/Divergent cognitive learning style and science related attitude. There exists positive relationship between Field-Dependent/Field-Independent cognitive learning style and academic achievement. Similarly, there exists positive relationship between Convergent/Divergent cognitive learning style and academic achievement. Moreover, there exists positive relationship between science related attitude and academic achievement.

5.3 Recommendations

1. The curriculum developers and educationists may consider individual differences (Field-Dependent / Field-Independent and Convergent / Divergent cognitive learning styles) while developing/revising science curricula of undergraduate level. Moreover, the problem solving skills, critical thinking skills and creativity may be incorporated in the student’s learning outcomes of BS science curricula.

2. University teachers may be aware of their own and their student’s cognitive learning styles. This awareness/understanding will be beneficial to make a good match between cognitive learning styles of both and predict student’s behaviors with regard to thinking, learning, and problem solving.

3. Trainings may be provided to university teachers regarding different teaching methodologies and orientation to educational psychology. Such trainings may be helpful for teachers so that they may apply varieties of teaching and learning strategies to fulfill learning needs of the learners.

4. Adequate facilities and instructional aids may be provided to the university teachers so that individual differences can be catered.
5. University Teachers may adopt differential teaching methods so that every undergraduate science student can be benefited from it. Teachers may devise strategies that students can use for the enhancement of learning in their own cognitive styles. Similarly, university teachers must use different techniques for assessment so that the evaluation of students with different learning style may be possible.

6. The behavior of learners can possibly be changed through education but it cannot be attributed to cognitive learning styles but also to the affective orientations. Therefore, science related attitude as an affective construct may be focused by the administrators, teachers, and educationists for the basis for both “intellectual preparedness” and “motivation in science learning”.

7. Science teachers may develop greater interest in the teaching science using cognitive learning styles as a means to motivate students and develop more positive science related attitude towards learning science subjects.

8. Proper career guidance and counseling must be provided to the undergraduate science students at the time of admission according to their respective cognitive learning styles so that they may select types of science subjects they might likely to succeed.

**Recommendations for Further Research**

1. Researches may be conducted to identify learning styles and students’ academic achievement in different science diciplines, and from there to design possible means of intervention for promoting effective learning and academic achievement.

2. A comparative study may also be conducted to identify cognitive learning styles of science and social sciences students. The effect of cognitive learning styles on their academic achievement may also be explored.

3. The research regarding awareness of cognitive learning style of undergraduate students may also be conducted in order to examine whether there is any effect of style awareness on the academic achievement of undergraduate science students.

4. A longitudinal study may also be conducted to examine the academic
achievement and science related attitude of science students by matching teaching methodology of teachers with the cognitive learning style of undergraduate science students.

5. The research may be conducted to explore the cognitive learning styles in relation with other aspects such as socioeconomic status, social interaction, parental education and brought up.

6. A survey research may also be conducted to explore the reasons of drop out students. It may be helpful to understand whether there is any connection of dropout and mis-match teaching methodologies of teachers.

7. A comparative research may also be conducted to find the cognitive learning styles of teachers and students so that the relationship of matching/mismatching of cognitive learning styles can be examined with the academic achievement of science students.

8. Universities must cooperate with the researches for data collection. Research is purely a scholarly work therefore, the other universities/DAI’s must accommodate the researchers to collect data for the improvement of teaching/learning process.
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Yang, B. (2007). *How students with different learning styles collaborate in an online*


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APPENDICES

APPENDIX A

RESEARCH TOPIC ALLOTMENT LETTER

NATIONAL UNIVERSITY OF MODERN LANGUAGES
Faculty of Advanced Integrated Studies & Research
Sector H-9, P.O. Shaigan, Islamabad
Tel: +92-9257646-30 ext: 156
Fax: 0092-051-9257672
Web: www.numl.edu.pk
ML.1-22/2004/AI58R
Dated: 16-07-2012

To,
Ms. Farkhunda Rasheed Choudhary
467-MPhil/Edu/Jan10

Subject: APPROVAL OF PHD TOPIC AND SUPERVISOR

1. Reference Academic Branch’s Notification No. ML.2-5/12/Adms/Acad dated 20-06-2012, the Board of Higher Studies and Research has approved the following vide its meeting held on 7th to 10th May 2012.

2a. Supervisor’s Name & Designation
Dr. Tanveer uz Zaman
Visiting Professor
NUML, Islamabad

2b. Topic of Thesis
"A Comparative Study of Cognitive Learning Styles and Attitudes among Science Students at Undergraduate Level"

3. You may carry out research on the given topic under the guidance of your Supervisor and submit the thesis for further evaluation within the stipulated time.

4. As per policy of NUML, all MPhil/PhD theses are to be run on turnitin by QEC of NUML before being sent for evaluation. The university shall not take any responsibility for high similarity resulting due to theses run from own sources.

5. Theses are to be prepared strictly on NUML’s format that can be had from Dr. Nighat Sultana (FAIS&R)

Telephone No: 051-9257646, Ext 309
E-mail: nighatashfaq@gmail.com

Prof. Dr. Shazra Munnawer
Dean, Faculty of Advanced Integrated Studies & Research

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APPENDIX-B
RESEARCH PERMISSION LETTER FROM NUML

TO WHOM IT MAY CONCERN

It is to certify that Ms. Farkhunda Rashid d/o Mr. Abdul Rashid, Reg. No. 467-Mphil/Edu/Jan10 is enrolled in the Mphil leading to PhD Programme in the discipline of Education, Faculty of Advanced Integrated Studies and Research, at this University. Currently she is working on her PhD research thesis titled "A Comparative of Study of Cognitive Learning Styles and Attitude towards Science with Academics Achievement of Undergraduate Science Students."

With a view to facilitating the candidate in gathering data for her research, you are requested to kindly provide her desired information pertaining to your organization, publications/relevant training and development material etc.

We take this opportunity to assure you that this research is a purely academic activity and the information provided by your organization will be used for research purposes only.

[Signatures]

Prof. Dr. Shazra Munawar
Dean, Faculty of Advanced
Integrated Studies & Research

Registrar
National University of Modern Languages
Islamabad
APPENDIX-C
REQUEST LETTER TO CONDUCT RESEARCH

7th October, 2013

Subject: Permission to Collect Data for PhD Research Work

The undersigned is an enrolled PhD scholar in National University of Modern Languages (NUML) Islamabad. The research scholar is doing research on the cognition and attitude of undergraduate science students. The data collection will be collected from the required sample (i.e. undergraduate science students of Universities/ DAI's of Islamabad). The undergraduate science students of your esteemed Institution/ University has also been included in the sample. The detail of required sample from your esteemed institution is attached herewith (Flag-A). Moreover, the affiliated university of research scholar (NUML) has also issued a letter for the data collection (Flag-B).

For the purpose of data collection, the following data will be required from your institution:

1. Responses of science students will be required from Hidden Figure Test (SHAPES)
2. Responses of science students will be required from Convergent/Divergent Tests
3. Responses of science students will be required from attitude questionnaire developed by researcher
4. The academic achievement (examination results) of the sample students will be required from the relevant Institution/University.

It is being assured that these tests/questionnaire will not be harmful for the students physically, emotionally, and psychologically. Moreover the collected data will be kept confidential and will be used for research purpose only.

Thanking you in anticipation.

[Signature]
Farkhunda Rabheed Choudhary
APPENDIX-D
LETTER TO THE EXPERTS FOR THE VALIDATION OF RESEARCH TOOL

Date: 3rd April, 2013

Subject: Validation of Research Instrument

Respected Sir/Madam,

Please find enclosed an attitude scale. The researcher wants to develop an attitude scale according to objectives of the study. In order to validate the tool, the expert’s opinion is being considered very significantly. The attached research instrument has also been sent to two more experts for content face and construct validity. The detail of the research tool is attached herewith. It consists of 76 items. The selection of the final statements will be as per expert’s recommendations.

The final draft will be sent to you for final validation. You will be requested to validate the final version of the instrument.

I will be highly obliged for you sparing time for this task. Thanking you in anticipation.

[Signature]

Fakhunda Rasheed Choudhary
APPENDIX-E
LETTERS FROM THE EXPERTS REGARDING VALIDATED RESEARCH TOOL (SCIENCE RELATED ATTITUDE QUESTIONNSIRE)

GOVT. OF PAKISTAN
MINISTRY OF CAPITAL ADMINISTRATION AND DEVELOPMENT
NATIONAL INSTITUTE OF SCIENCE AND TECHNICAL EDUCATION
(CURRICULUM UNIT OF SCIENCE EDUCATION SECTOR)

No.F.2-1/2013-CU

Dated: 03-07-2013

SUBJECT: Validation of Research Instrument

Please refer to your letter dated: 12-06-2013 on the above subject. I have validated your instrument on “Attitudes towards science” and find the same to the best of my satisfaction. Some necessary corrections are made on the copy of instrument attached herewith.

(Dr. Alyas Qadeer Tahir)
Director (Curriculum Unit)

Farkhunda Rasheed Ch.
Lecturer
Room # 104, Block # 10
Allama Iqbal Open University
H-8, Islamabad
TO WHOM IT MAY CONCERN

Subject: Instrumentation/Questionnaire Validation Certificate

I have reviewed the Attitude Questionnaire developed by Farkhunda Rasheed Choudhary Reg# 467-M.Phil/Edu/Jan-10 for the Topic: "A Comparative Study of Cognitive Learning Styles and Attitude among Science Students at Undergraduate level." This Questionnaire is now according to the objectives of the study and valid for data collection after certain modifications.

Dr. Mariam Din
Lecturer
National University of Modern Languages, Islamabad

Mai D. 17th August 2013
# HEC Recognized Universities/Degree Awarding Institutions

**HEC Recognized Universities and Degree Awarding Institutions**

HEC RECOGNIZED UNIVERSITIES/DEGREE AWARDING INSTITUTIONS (DAIs) OF PAKISTAN IN PUBLIC & PRIVATE SECTOR AS ON SEPTEMBER 2011

Degree/Thousand issued only by the Universities/Degree Awarding Institutes (DAIs) listed here will be recognized and attested by the Higher Education Commission, Islamabad. For more information keep visiting [http://www.hec.gov.pk](http://www.hec.gov.pk/)

Click here for HEC recognized Campuses of Public and Private sector Universities/Degree Awarding Institutes.

Click here for HEC List of Affiliated Colleges of Public and Private sector Universities/Degree Awarding Institutes.

### PUBLIC SECTOR UNIVERSITIES/DEGREE AWARDING INSTITUTES

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**Universities/DAIs chartered by Government of Khyber Pakhtoonkhwa**

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<td>Bismillah University of Science and Information Technology, Peshawar</td>
<td>Peshawar</td>
<td><a href="http://www.bust.edu.pk">www.bust.edu.pk</a></td>
</tr>
</tbody>
</table>

**Universities/DAIs chartered by Government of Balochistan**

<table>
<thead>
<tr>
<th>S. No</th>
<th>University/DAI Name</th>
<th>Main Campus Location</th>
<th>Website Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ali-Hamad Islamic University, Quetta</td>
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<td><a href="http://www.aiu.edu.pk">http://www.aiu.edu.pk</a></td>
</tr>
</tbody>
</table>

**Universities/DAIs chartered by Government of Azad Jammu & Kashmir**

<table>
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<th>University/DAI Name</th>
<th>Main Campus Location</th>
<th>Website Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Aligarh University, Bharatpur, A.J.K.</td>
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<td><a href="http://www.aligarh.edu.pk/">http://www.aligarh.edu.pk/</a></td>
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<tr>
<td>2</td>
<td>M.B.B.S.O.U. Islamic University, AJK</td>
<td>AJK</td>
<td><a href="http://www.ou.edu.pk">http://www.ou.edu.pk</a></td>
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</table>

**Universities banned for enrollment**

<table>
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<th>Main Campus Location</th>
<th>Website Address</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>University of Estak, Hyderabad</td>
<td>Hyderabad</td>
<td><a href="http://www.ues.edu.pk">http://www.ues.edu.pk</a></td>
<td>New Admission closed w.e.f 01.01.2011. HEC will only recognize the degrees awarded to students already enrolled prior to 1st January, 2011.</td>
</tr>
</tbody>
</table>
APPENDIX-G
PERMISSION TO USE TESTS

Allama Iqbal Open University, Islamabad
Science Education Department

25th April, 2013

Subject: Permission to Use Research Tool

It is stated that the undersigned has allowed Ms. Farkhunda Rasheed Choudhary to use Hidden Figure Test (SHAPES) for her PhD research work “cognitive learning style and attitude among science students at undergraduate level”.

Prof. Dr. Faiz-ul-Ata Zaman
Dean Faculty of Education
Chairman Science Education Department
To,
Farkhunda Rasheed Choudhary,
Lecturer,
Science Education Department,
Allama Iqbal Open University, Islamabad

25th April, 2013

Subject: Permission to Use Convergent/Divergent Tests for PhD Research Work

I hereby allow Ms. Farkhunda Rasheed Choudhary to use Convergent/Divergent Tests for PhD Research Work. I hope these tests will be useful for her research work as I found them helpful in my research work.

Dr. Rehmatullah Bhatti
Vice Principal, IMCB, G-6/2,
Islamabad
APPENDIX-H
DEMOGRAPHIC INVENTORY

Demographic Inventory

Please provide personal information and "Tick (v)" the relevant option only.

1. Name: ____________________________ 2. Session: ________________________________

3. Registration No. ___________________ 4. Institute/University: _________________________

5. Gender
   ○ Male  ○ Female

6. Age
   ○ 14-15 year  ○ 16-17 year  ○ 18-19 year  ○ 20-21 year  ○ More than 21

7. Location
   ○ Urban Area  ○ Rural Area

8. Marks Obtained in F.Sc
   ○ 500-600  ○ 600-700  ○ 700-800  ○ 800-900  ○ 900 and above

9. Please mention subjects you studied in F.Sc
   ○ Pre-medical  ○ Pre-Engineering  ○ Computer Science  ○ Other

10. Please indicate who guided you to opt above mentioned BS Program:
    ○ Self  ○ Father  ○ Mother  ○ Brother
    ○ Sister  ○ Relative  ○ Any other

11. Please mention the educational level of your Father
    ○ Primary  ○ Secondary  ○ Higher Secondary  ○ Graduate
    ○ Post Graduate  ○ Engineer  ○ Doctor  ○ PhD

12. Please mention the educational level of your Mother
    ○ Primary  ○ Secondary  ○ Higher Secondary  ○ Graduate
    ○ Post Graduate  ○ Engineer  ○ Doctor  ○ PhD

13. What is the Profession of Your Father

14. If your mother is working women, what is the Profession of Your Mother

15. Which BS Program you are enrolled in?
   a. Basic Sciences  b. Computer Sciences  c. Engineering Sciences
      ○ BS Physics/  ○ BS Computer Science  ○ BS Computer Engineering/
      Applied Physics ○ BS Math  ○ BS Electrical Engineering/  ○ BS Software Engineering
      ○ BS Biosciences/  ○ BS Engineering/  ○ BS Biomatics  ○ Telecom Engineering
      Bioinformatics
This is a test of your ability to recognise simple SHAPES, and to pick out and trace HIDDEN SHAPES within complex patterns.

The results will not affect your school work in any way.

YOU ARE ALLOWED ONLY 15 MINUTES TO ANSWER ALL THE ITEMS.
TRY TO ANSWER EVERY ITEM, BUT DON'T WORRY IF YOU CAN'T.
DO AS MUCH AS YOU CAN IN THE TIME ALLOWED.
DON'T SPEND TOO MUCH TIME ON ANY ONE ITEM.
LOOKING FOR HIDDEN SHAPES

A simple geometrical figure can be ‘hidden’ by embedding it in a complex pattern of lines. For example, the simple L-shaped figure on the left has been hidden in the pattern of lines on the right. Can you pick it out?

Using a pen, trace round the outline of the L-shaped figure to mark its position.

The same L-shaped figure is also hidden within the more complex pattern below. It is the same size, the same shape and faces in the same direction as when it appears alone. Mark its position by tracing round its outline using a pen.

(To check your answers, open out the flap on the back cover of this booklet.)
Find SHAPE H

Find SHAPE E
Find SHAPE B

Find SHAPE D
Find SHAPE H

Find SHAPE E
Find SHAPE F

Find SHAPE A
Find SHAPE E

Find SHAPE H
Find SHAPE E

Find SHAPE H
Find SHAPE C

Find SHAPE B
Find SHAPE G

---

Find SHAPE H
Find SHAPE D

Find SHAPE A
Find SHAPE E

Find SHAPE F
THE SHAPES YOU HAVE TO FIND

A

B

C

D

E

F

G

H
APPENDIX-J
CONVERGENT DIVERGENT TEST

These tests on the following pages aim to measure your ways of thinking. The results will not affect your academic work or exam any way.

Test 1

Time Allowed: 4 minutes

When you are writing, it is often necessary to **think of several different words having the same meaning**, so that you do not have to repeat one word again and again. In this test you are asked to think of words having meaning which are the same or similar to a given word. The given words will be ones that are well known to you.

**For Example:**

If the word is *short*, you would write at least some words like written below:

Short: Brief abbreviated momentary limited
Deficient abrupt petite crisp compact

Now try the following words. You probably will not be able to fill in all the spaces, but write as many words as you can think of.

1. **Strong:**

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

2. **Clear:**

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

3. **Dark:**

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………
In this test you will be asked to write as many sentences as you can. Each sentence should contain the four (04) words mentioned and any other words you choose.

For Example:  TAKE FEW LAND LITTLE

1. Few crops take little land.
2. Take a few little boats supplied to land.
3. Could you take a few little people with you to see my green land?

Note:

1. All the four words are used in each sentence.
2. The words must be used in the form that is given, for example, you cannot use “taking” instead of “take”
3. Notice that the sentences may be of any length
4. All sentences must differ from one another by more than merely one or two changed words, such as different pronouns or adjectives.

Now try the following words. Remember to number new sentence as was done in the example above.

1. Write Words Long Often

2. Friend Man Year Catch
This is a test of your ability to think up a number of different symbols that could be used to stand for certain words or ideas.

For Example:
The word is "electronics". This word could be represented by many symbols or drawings as shown below.
As you know there are many other symbols that could represent the word "electronics"

Now try as many symbols as you can think of (up to five) for each word or subject below. Each drawing can be as complicated or as simple you choose (No artistry required)

1. Energy:

2. Technology:

3. Happiness:

4. Silence
This is a test to see how many things you can think of that are alike in some way.

For Example:

What things are always red or that are red more than any other color? You may use one word or several words to describe each thing.

<table>
<thead>
<tr>
<th>Tomatoes</th>
<th>Bricks</th>
<th>Blood</th>
</tr>
</thead>
</table>

Go ahead and write all the things that are “Round” or that are Round More Often than any other shape.

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
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</tr>
</tbody>
</table>
Test 5

Time Allowed: 2 minutes

- This is a test of your ability to think rapidly about as many words as you can that begin with one letter and end with another.

For Example:

The word in the following list all begin with “S” and end with “N”

<table>
<thead>
<tr>
<th>Sun</th>
<th>Spin</th>
<th>Stain</th>
<th>Solution</th>
</tr>
</thead>
</table>

- Now try thinking of word beginning with “G” and ending with “T”. Write them on the lines below. Name of people or places are not allowed.

.......................... .......................... ..........................

.......................... .......................... ..........................

.......................... .......................... ..........................
This is a test to see how many ideas you can think about a topic. Be sure to list all the ideas you can think about a topic whether or not they seem important to you. You are not limited to one word. Instead you may use a word or a phrase to express each idea.

For Example:

“A train Journey”. Examples are given below of ideas about a topic like this.
Number of miles suitcases the railway station people in the train

Now list all the ideas you can about “working in laboratories”.

.......................... .......................... ..........................

.......................... .......................... ..........................

.......................... .......................... ..........................

.......................... .......................... ..........................
Please read carefully and Tick "✓" the relevant opinion indicating how much you agree or disagree with the statement.

<table>
<thead>
<tr>
<th>Sr.#</th>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Uncertain</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>The study of Science will be helpful for my future work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Good jobs can be obtained without studying science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Science subjects are more interesting than other subjects.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>I dislike discussing science activity after class time.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>I will hardly use science in future.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6.</td>
<td>Having knowledge of science will be helpful to get a good job.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>7.</td>
<td>Studying science is boring.</td>
<td></td>
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</tr>
<tr>
<td>8.</td>
<td>I like to have discussions regarding science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td>Science subjects are important to be studied.</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>I dislike a job relevant to scientific work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>I enjoy attending science classes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>I dislike spending extra time on science experiments.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Studying science subjects is wastage of time.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>I would love to select a profession related to science after passing out.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>There is boring material in science classes.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>I like to do science experiments at home.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Study of science will help me in solving problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>Choosing a career in science would be dull and boring.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Science is one of the most interesting subjects for me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>I dislike science articles in newspaper/magazine/websites.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>Most of the problems in routine work are created by science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>Selecting career in science would be beneficial for me.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>For me science subjects are the least interesting subjects.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
24. I like to read science articles in newspaper/magazines/websites.

25. Science is very much in practice in every day.

26. Working in science related field is not worth it.

27. I like to do some extra work other than assigned task in science.

28. I think spending extra time on science is wastage of time.

29. In practical life, science has negligible role.

30. Working in science related field would be rewarding.

31. I hardly complete my assigned task in science.

32. In spare time, I would like to use science equipment to improve science knowledge.

33. I am intended to do advance studies in science.

34. A job requiring science knowledge would be uninteresting.

35. I like reading ahead from my science course books.

36. In my spare time, I would not like to engage myself in science related activity.

37. I do not think I could do advanced studies in science.

38. I would prefer a job requiring science knowledge.

39. I dislike reading ahead of my course books.

40. I like to engage myself in a science related activity.
<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Valid Percent</th>
<th>Cumulative Percent</th>
</tr>
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<td>.9</td>
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</table>
## APPENDIX-M

**INITIAL TABULATION DATA OF SCORES OF CONVERGENT DIVERGENT TESTS**

<table>
<thead>
<tr>
<th>Convergent.Divergent</th>
<th>Frequency</th>
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APPENDIX-N

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APPENDIX-O

Proof Reading/Editing Certificates

Proof Reading/Editing Certificate

Subject: Review of Ph.D thesis of Scholar Ms. Farkhunda Rasheed Choudhary

I have reviewed the abstract and chapter#1 of Ph.D thesis of Farkhunda Rasheed Choudhary Reg No. 467-M.Phil-Edu/Jan 10, entitled “A Comparative Study Of Cognitive Learning Styles And Attitude Of Science Students At Undergraduate Level” and suggested few English language/grammatical corrections. The researcher has incorporated the given corrections and these parts of manuscript are now acceptable for the scholar’s Ph.D thesis.

Prof. S.M. Abdul Rauf

HoD, Women’s Institute of Science and Humanities, H-8, Islamabad

(Former HoD English, International Islamic University, Islamabad)
TO WHOM IT MAY CONCERN

Ms. Farkhunda Rasheed Choudhary, Reg. No. 467-M.Phil-Edu/Jan10, Ph.D scholar had submitted her thesis entitled "A Comparative Study of Cognitive Learning Styles and Attitudes of Science Students at Undergraduate Level" for editing two weeks ago.

The undersigned has gone through all pages for editing. It is a well prepared manuscript; however, I suggested some minor corrections from editing point of view.

The scholar had been suggested to incorporate few corrections. It is hereby certified that the thesis entitled above has been thoroughly edited and now ready for presentation.

Wish of best Luck.

[Signature]

Shahida Rani Shah
Editor