IMPACT OF LOW COST TEACHING MATERIAL ON CREATIVITY, ACHIEVEMENT AND ATTITUDE TOWARDS CHEMISTRY AT SECONDARY LEVEL IN KHYBER PAKHTUNKHWA

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Abstract

This study aimed to investigate the Impact of low Cost Teaching Material on Creativity, Achievement and Attitude towards Chemistry at Secondary level in Khyber. A related purpose was to investigate the gender differences in creativity, achievement and attitude towards Chemistry. The research strategy adopted in this study was mixed methods; both quantitative and qualitative research methods were utilized. As triangulation are the key characteristics of mixed method. Therefore, triangulation was in this research as well.

To assess creativity of the students a test of creativity was developed. The test was comprised of five components, i.e. sensibility to problem, fluency, flexibility, originality and elaboration & redefinition. The reliability of the creativity test of science (Chemistry) was established using the test - retest method. The test-retest took 25 days. The test-retest reliability coefficient was found to be 0.87. Achievement test was prepared according to the style of routine exam of the schools / colleges. The objective of this particular study is to investigate the impact of teaching science through low cost materials on students’ achievement. Therefore, on the bases of cognitive domains, (Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation) of Bloom’s Taxonomy of educational objectives the researcher developed achievement tests (pre-tests and post-test) from the contents and activities of 12 grad of the Khyber Pakhtunkhwa Textbook of Chemistry. There were 29 items and every item had four options. The test was shown to practicing teachers in 15 schools and their comments were sought. And necessary changes were made in the questions and test as a whole. The test was also piloted to 80 students and item analysis was carried out. Similarly, a modified versiob of Test of Science-Related Attitude (TOSRA) was used to measure students’ attitude towards chemistry. The test was purely constructed on Likert scale to measure the students’ attitude towards chemistry on the factors such as Behavior tendency to learn chemistry, Liking for chemistry laborastory work , Liking for chemistry theory lesson , Evaluation belief about chemistry, Leisure interest in science and Enjoyment of chemistry .Besides these tests two interviews (one for teachers and one for students) were also conducted for data collection. Purposive sampling technique was adopted for selection of students for interviews. The selection of the students was non-random. The researcher selected nine students.
for structured interview. Three students from high achiever group three students from average
and three from lower achieving groups. The selection was on the bases of achievement in their
creativity test, pre-test and post-test and on the researcher observation Likert check list.
There were some threats (extraneous variables) which could affect the experimental study. The
researcher controlled these threats, because any uncontrolled extraneous variable could affect the
performance on the depending variable to the validity of an experiment. During pilot study the
researcher came to know that what type of internal and external validity could be controlled. On
the bases of threats the researcher selected an institution and sample where all the threats were
controlled. The most important internal threats were mortality, instrumentation, testing and
differential selection of participants faced during pilot study. Due to mortality, the reduction in
the number of participants occurred over time as individuals dropped out for different reasons.
26 out of 80 participants dropped out. The researcher, in broad study, overcame the mortality of
groups by obtaining demographic information about the participants before the start of the study.

Quantitative data was analyzed using t-test through Statistical Package for Social Sciences
(SPSS). Similarly qualitative data from interviews was analyzed using qualitative data analysis
techniques. Main findings of the study indicated that students in experimental group, taught
through activity with low cost materials, showed significantly greater creativity, achievement
and attitude towards chemistry than the students in control group. This study further showed that
female students, both in experimental and control groups, outperformed their male counterparts.
This shows that teaching through activities with low cost material produced better results in the
terms of creativity, achievement and attitude towards chemistry.
CHAPTER 1

INTRODUCTION

Higher Secondary Stage is the most crucial stage of school education because at this stage specialized discipline based content oriented courses are introduced. Students reach this stage after 10 years of general education and opt for Chemistry with a purpose of mostly for pursuing their career in basic sciences or professional courses like medicines, engineering, technology and studying courses in applied areas of science and technology at tertiary level. Therefore, at this stage there is a need to provide learners with a sufficient conceptual background of Chemistry to promote their creativity and attitude towards chemistry which will make them competent to meet the challenges of academic and professional courses after the higher secondary stage.

1.1 Background of the study

The world civilization owes a great deal of gratitude to modern scientific inventions and discoveries, because this revolution has brought about a change in the world. As a result developed countries have made a wonderful progress, which has enabled them to utilize their material resources for the benefits of mankind. The prosperity of a nation largely depends on scientific advancement, which is based on scientific and technological development. That is why all nations of the world give great importance to scientific and technological education in order to equip their students with scientific skills.

As science and technology has become a focal point due to its importance in the present scenario. Therefore, it is imperative for every individual to recognize the basic essentials of science and their applications in everyday life. Hurd (1990) states that by recognition of the critical role that is played by science education in the social, economic and personal life of the people, ‘scientific and technological literacy for all’ is strongly advocated. This now invites the
attention of policy makers to prioritize the scientific and technological knowledge that has a critical role in development and to sustain the progress. Only those countries are sustaining their developments that are giving high priority to scientific and technological education in their education policy formulation.

Pakistan, as a developing country, has always laid much emphasis on science education which has remained a priority of the Government. That is why the national policy of the Government recognized the timely need to promote science education. All education policies of Pakistan focus on science education and recommended the needed resources for the achievement of this objective.

In early 1970s, reforms in science education were brought worldwide. It was realized that in the science teaching, developing process skills are more important than merely telling them the science facts; active involvement of students should be ensured in experimentation, solving scientific problems, testing ideas related to science concepts, and making science discoveries (Doty, 1985). However, telling factual information of science is still in practice, consciously or unconsciously, rather than enabling the students to understand science processes. More often students’ success in science is measured by ability to remember and narrate a set of facts when needed (Dantonio & Beisenherz, 1990). Teaching of science that strives for only to communicate students the accumulated knowledge, results in acquiring a superficial level of understanding, undoubtedly ignoring the development of mental faculties. Teaching scientific reasoning only as a set of procedures is ineffective equally if it is not supported by some particular stuff.ie, laboratory equipment, chemicals and charts. Science educators should facilitate their students in the acquisition of both scientific knowledge and framing their habits of mind scientifically at the same time (Ornstein, 2006). This purpose may be fulfilled when the students are taught with activity based teaching in an effective manner.

Mishra and Yadav (2013) consider activity based teaching is effective for overall development of children at the elementary level. Similarly, Faiza (2012) argues that the activity-based teaching for the development of high order skills in students to promote their thinking ability to adjust themselves to learning environment. Edward (2001), Harfield, Davies and
Kenley (2007) stress on active based teaching over traditional methods of teaching on two points, i.e., the active role of students and collaboration among the students.

According to Archibong (1992), Suydam, Marilyn and Higgins (1977) and Hussain, et al. (2011) science is an activity based approach and have found that learning by doing is the most effective method for learning science. Activity-based approaches provide students with hands on experiences. The young students like doing something rather than listening or observing.

Activity-based teaching is an approach to education focusing on the idea that students should be engaged through actions. This is in contrast to some traditional forms of teaching in which an educator, lecturer or others, communicate information to students who are expected to absorb what they are told. In activity-based teaching, an educator serves the function of facilitating, assisting students through the learning process and providing them with guidance. Furthermore, the purpose of activity-based is to engage students directly, drawing them into a lesson so that they become a participant in their own learning.

Most of the schools do not have separate chemistry laboratories and those having chemistry laboratories are not well equipped. However, it is certainly possible to design low cost activities and equipment using easily available materials for teaching.

Students’ creativity is an important factor in teaching learning process, especially with reference to science learning. It refers to the individuals’ tendency to generate or recognize ideas and possibilities to solve problems (Robert 1982). According to Gardner (1993) a creative person is one who “regularly solves problems, fashion products, or define new questions in a domain in a way that is initially considered novel, but that ultimately comes to be accepted in a particular cultural setting”.

The central features of creativity are fluency, flexibility and originality (Hu and Adey, 2002):

- **Fluency** means the number of original ideas produced,
- **Flexibility** is the ability to ‘change tack’, not to be bound by an established approach after that approach is found no longer to work efficiently.
- **Originality** can be explained statistically: an answer which is rare, which occurs only occasionally in a given population, would be considered original.
To develop the problem solving capacity and critical thinking of learners, there must be some healthy activities during the teaching learning process. Activity based teaching engages the learner to acquire, organize, generalize, utilize and construct information creatively.

As creativity is an essential factor for success in science education because it is the qualitative impetus behind any given act of creation, and it is generally perceived to be associated with intelligence and cognition. Therefore, the creative spirit of the students should be identified and stimulated.

Chemistry is physical science which is largely concerned with the universe. It is an experimental science and gives an insight on the matter and tries to answer the very basic question in the mind of a human being, i.e., what is the composition of matter and how it can be transformed from one form to another? (Shah, 2013, p,4). Chemistry is an essential component of science education. The basic concepts of chemistry are the part of the education required not only by chemists but also by biologists, physicists, medical doctors, engineers, pharmacists, and others. Perhaps the most contribution of chemistry is that it will develop you a systematic and logical approach that will serve you well in solving problems in any field. The attitude and skill developed through learning chemistry are perhaps just as important as the specific knowledge acquired. (Mustaqeem, 2009, p, 12)

Attitude towards science denotes interest or feeling towards studying science. It is the students’ disposition towards liking or disliking science (Yara 2009). This disposition leads to positive or negative attitudes which directly affect the learning process and shape the future lives of individuals. For attitude towards chemistry Shair (2011) have marked three features. The first and probably the most important is the scientific attitude of mind which insists on reasoning objectively from fact securely established by physical phenomena. The second is the development of a large number of wonderful instruments for observation and measurement to update the students in the field of chemistry. The third is the effective use of teaching strategies in the field of chemistry. Therefore, we ought to mold the ideas of the young students towards these scientific facts (p,14). Salta and Koulougliotis (2011) identified factors that could positively influence students’ attitude to learn chemistry; these factors could be organized into three main categories:
• Teaching approaches
• Educational tools
• Non-formal educational material and activities.

Hofstein and Naaman (2001) suggested three factors for enhancing attitudes towards learning chemistry

• The methods used to present the content (e.g. Relevance)
• Instructional techniques that is implanted.
• Gender issues.

Students with positive attitude toward chemistry achieve more and also more likely to incorporate science into their daily lives when they appreciate its importance. Thus, our students need to be creative thinkers and having positive attitudes towards chemistry to ensure better performance in chemistry.

In advance countries science is being taught in activity based approach. But for the third world countries, like Pakistan, where the economic resources are very limited, is very difficult to provide full facilities to the students in their proper development in the scientific society. Therefore, to keep our students on the scientific track properly, it is necessary that science must be taught with low cost activities. There are large number of objects of daily use around us, which could be utilized for the purpose of experiments in the laboratories, such as a bottle, wires and glasses. Such materials can be used by the teachers in place of expensive things, such as Nelson cell, Acetylene gas apparatus, Barometer, Electrolytic cell, Apparatus for Hydrogen gas preparation, etc. in the laboratories for performing the practical.

Scientific knowledge that we utilize today must have creativity, foresight and vision for, it has to develop the individuals for the competitive world of tomorrow. There are some students who may become creative scientists. They must have to promote positive attitudes toward chemistry and should have achievement in it. For development of scientific skills, illustration and provision of opportunities for scientific investigation the use of low cost materials is equally effective.

1.2 The Research Problem
The purpose of this study was to find out the impact of low cost teaching material on creativity, achievement and attitude towards chemistry at the secondary level in Khyber Pakhtunkhwa. The study identifies the setting of low cost teaching material used by textbooks. The findings of the study could provide some insights for chemistry educators about the incorporation of activity based teaching methods that promote better understanding of a lesson as it is learning by doing. It inspires the students to apply their creative ideas, knowledge, and minds in solving problems. This thesis is substantially different from most studies in the field of multiple representations research, as it addresses low cost teaching material use by teachers and students in predominantly natural settings of classroom activity. A variety of perspectives were engaged in this study that not only include the school chemistry textbooks and teachers’ everyday instructional use of low cost teaching material but also describes students’ perceptions of teachers’ instructional practice as well as examining the cognitive roles that activities and text may have on students’ understanding of chemistry concepts. The study provides recommendations for authorities and Curriculum Designers, Teacher Trainers, practicing teachers, students and textbook design concerning the appropriate and efficient methods of low cost teaching material in chemistry education, with particular emphasis at the senior secondary level.

The broad purpose of this study has six phases as described below:

Phase 1: Investigate the impact of low cost teaching materials on students’ creativity.

Phase 2: Finding out the impact of low cost teaching materials on students’ achievement in science.

Phase 3: Assessment of the impact of low cost teaching materials on students ‘attitude towards science.

Phase 4: Identify gender wise impact of low cost materials on students’ Creativity

Phase 5: Comparison of the gender difference of the impact of low cost materials on students Achievement

Phase 6: Comparison of the gender differences of the impact of low cost teaching materials on students Attitude towards science.
1.3 Objectives of the Study

In order to address the rationale of this study, the following six research objectives were highlighted.

1. To investigate the impact of low cost teaching materials on students’ creativity.
2. To find out the impact of low cost teaching materials on students’ achievement in chemistry.
3. To assess the impact of low cost teaching materials on students ‘attitude towards Chemistry.
4. To identify gender difference in the impact of low cost materials on students’ Creativity
5. To compare the gender difference in the impact of low cost materials for students Achievement
6. To compare the gender differences in the impact of low cost teaching materials on students Attitude towards science.

1.4 Research Questions

To achieve the objectives of this particular study the following research questions were investigated;

1. What is the impact of low cost teaching materials on students’ creativity?
2. What is the impact of teaching low cost materials on students’ achievement in Chemistry?
3. What is the impact of teaching low cost materials on students ‘attitude towards Chemistry?
4. What is gender difference in the impact of low cost teaching materials on students’ Creativity?
5. What is gender difference in the impact of teaching low cost materials on students’ achievement in Chemistry?
6. What is gender difference in the impact of low cost teaching materials on students’ attitude towards chemistry?

1.5 Delimitation of the Study

The study was delimited to

1. The science stream, 12th grade students only.
2. Khyber Pukhtunkhwa textbook of Chemistry for grade 12th

1.6 Significance of the Study

This study is significant for several reasons. Firstly, this study is likely to guide the curriculum designers to incorporate low cost activities in the curriculum that makes the curriculum more effective, interested and attractive for the students and science teachers. Secondly, this study is likely to help in building the capacity of science teachers to use and fabricate low cost activities by arranging different workshops and training that may help the effective teaching of science. Thirdly, this study is likely to create a culture of low cost activity which will enrich our laboratory activities. Fourthly, the findings of the study provided the activity based teaching evidence about the contents and methodology of activities that can develop thinking skills of the students. As science teachers in Pakistan aviod activities based teaching especially, teaching with low cost material therefore, this study is likely to guide the teacher trainers to assist the in-service and pre-service teachers to incorporate the use of low cost materials in the practical way to improve laboratory activities, student’s creativity, attitude and their conceptual understanding in science education. Fifthly, this study is likely to contribute in the educational research relating to creativity, attitude in relation to low cost activity and the conceptual understanding of the science students. Lastly, this study also encourages textbook designers to fully consider the representational features of low cost diagrams so that the scientific concepts can be better understood by science students.

1.7 Theoretical Framework
The main investigation of this study is concerned with the impact of low cost teaching material on the students’ creativity, achievement and attitude towards chemistry. Creativity is one essential variable for success in science and it is commonly taken as a tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems. Creativity in this study is taken as the numerical score assigned to individual performance on a test of creativity of science based on activities with low cost materials and the contents of the textbook of chemistry for grade 12. The creativity test for science was aimed to measure the creativity of students. For this purpose, no test was available that could measure the students' creativity through activity with low cost materials. Guilford’s Theory: Creativity as Divergent Thinking (1956) and Mednick’s Theory (1962), were the bases for developing creativity test. However, the researcher in this particular study has followed the Philips (2008) style with modification and has developed his own creativity test for chemistry (CTC). This is purely developed for chemistry of grade 12 students with low cost materials. This test consists of five components, i.e., sensitivity to the problem, fluency, flexibility, originality and elaboration and redefinition. Each component has certain factors discussed in details in chapter two of the thesis.

Similarly, attitude toward chemistry and science education are as united as soul and body that ensure the influx of new scientists. As Hafiz (2012) said that to ensure the influx of new scientists, it is important to view how science is taught in schools and how this approach affects students’ willingness to take an active role in their science learning”. Science education emphases on students attitude toward science and considers attitude as an important component of science education.” Therefore, the investigation of students’ attitudes towards science has been a substantive feature of the work of the science education research community for the past many years. To measure attitude toward science a large number of tools are available for measuring attitude towards science covering different dimensions of attitude, i.e., cognitive, affective and behavioral components. The most popular test which has been used the world over since its development by Fraser (1978) is the Test of Science-Related Attitudes (TOSRA). In most countries (TOSRA) has been used with different version and modification. For this particular study, the researcher decided to develop a test on a Likert type
scale on cognitive, affective and behavioral components having liking for chemistry theory lesson, adoption attitude toward science, Liking for chemistry laboratory work and leisure interest in science as factors. But the main component was low cost activities.

Achievement is not more than the act of achieving or successful performance. In the words of Zaman (2011), achievement is the accomplishment of the assigned task. The chemistry achievement, in this study, is taken as operational achievement. The achievement test was constructed based on converging thinking to measure the operational achievement.

In this particular study mixed method design was adopted, therefore, the researcher has to control the extraneous variables (threats). For the internal validity the threats such as History, Maturation, Instrumentation, Differential selection of participants, Mortality were controlled by obtaining demographic information about the participants before the start of the major study. According to Gay and Mills (2011) a researcher must consider many factors when attempting to identify and control extraneous variables.’ For external validity the researcher controlled threats such as Multiple Treatment Interference and Selection-Treatment interaction.

1.8 Methodology of the Study

In this section research paradigm and research design are discussed.

1.8.1 Research Paradigm and Research Design

This research followed post positivist paradigm. The researcher believes that reality cannot be measured exactly and that there are multiple realities within the world in contrast to positivist approach, which begins with the belief of the existence of a single reality. (Lincoln & Guba, 1985; Strauss & Corbin, 1990)

Mixed method design was adopted for this study because of the level and nature of the participants (secondary science students) and the educational environment (science classes). Mixed method is the combination of quantitative and qualitative research methods that give a clear picture of the situation and those subjects involved in the sample. According to Creswell
mixed methods research is “practical” in the sense that the researcher is free to use all methods possible to address a research problem. It is also practical” because individuals tend to solve problems using both numbers and words, they combine inductive and deductive thinking. Moreover, by mixing the datasets, the researcher provides a better understanding of the problem than if either dataset had been used alone. According to (Jick 1979) mixed methods research provides strengths that offset the weaknesses of both quantitative and qualitative research. This has been the historical argument for mixed methods research for the last 25 years.

This approach allows ‘triangulation of data’. Triangulation refers to the use of more than one approach to the investigation of a research question in order to enhance confidence in the ensuing findings. Webb et al. (1966) who suggested “Once a proposition has been confirmed by two or more independent measurements persuasive evidence comes through a triangulation of measurement processes” (P.3) therefore, this approach is fundamental in obtaining validity in research. Teaching with activities, especially with low cost materials, is not a simple process. It develops creativity, achievement and attitude towards science to science students. Therefore, to find out the impact of teaching low cost material on the creativity, achievement and attitude towards science (Chemistry) mixed method was adopted.

1.9 Population of the Study

There are seven Divisions in Khyber Pakhtunkhwa which have been further divided into twenty seven districts. All the science students of government and private colleges of Khyber Pakhtunkhwa, studying at the 12th grade, formed the population of the study.

1.10 Sample of the Study.

The convenient sampling approach was adopted due to the nature of the study. All the 12th grade students enrolled in Oxford Education Academy Batkhela, Khyber Pakhtunkhwa, Pakistan, for the following reasons.

- This institution was accessible to researcher.
- The Principal and staff of the Institution were cooperative.
• This was a well populated institution and students from far flung area were enrolled here.
• Both the genders were enrolled.

1.11 Research Instruments

Three tools were used in this research to collect data from students, creativity test, modified version of Science related attitude test (TOSRA) for attitudes towards chemistry and achievement test to collect quantitative data. Two interviews, one from students and the other from teachers were conducted to collect qualitative data.

1.12 Data Collection

Data were collected through research instruments (discussed in section 1.11). In the first phase quantitative data were collected from both groups, i.e., experimental and control by the researcher himself by administering the instruments, while in the second phase qualitative data were collected through structured interviews from nine students and three teachers.

1.13 Data Analysis

Quantitative data collected through Creativity Test, Test of Science Related Attitude (TOSRA) and Achievement Test were analyzed with the help of statistical techniques like mean, standard deviation, t-test and correlation analysis. Some detailed information about preparation, implementation and evaluation of the assessment tools used in data collection are given under their heads. Qualitative data from interview was analyzed using a thematic technique to identify popular themes and pattern in responses.

1.12 Definitions of the Key Terms

Low cost activities; those activities which are performed in science laboratories with the help of low cost apparatus are called low cost activities.

Creativity indicator: A tool or trait used to evaluate creativity among individuals. Examples of creativity indicators include elaboration, originality, and openness (Torrance & Safter, 1999).
Flexibility: It is one of Torrance’s creativity indicators characterized by lack of tendency. To perceive problems from only one perspective (Jausovec, 1994 as cited in Cherazade2007), it generates a wide range of idea or a variety of possibilities.

Originality: Originality is one of Torrance’s constructs that refers to the ideas that are unique unusual or innovative. This is usually comes at the end of the brainstorm.

Fluency: It is one of Torrance creativity indicators. It is the ability to generate many ideas, possibilities or solutions.

Elaboration: It is one of Guilford creativity indicators which is characterized by the ability to use world, images and action to enhance meanings.

Attitude towards science: According to Yara (2009), attitude towards science denotes interest or feeling towards studying science. It is the students’ disposition towards liking or disliking science.

Private institutions: private institutions are those institutions which are privately run and owned by an individual or group of individuals.

Equipment
The term 'equipment’, as used in this, covers all the support material for science teaching excluding textbooks, other printed materials and the usual classroom materials and facilities, such as chalk, blackboards and furniture. It may also include perishable items (e.g. Glassware) and consumables (e.g. Chemicals).

Convergent thinking
Convergent thinking is based on familiarity with what is already known, and is most effective in situations where a ready-made answer exists and needs simply to be recalled from stored information, or worked out from what is already known by applying conventional and logic search, recognition and decision making strategies. The ideas are eliminated to arrive at a single correct answer, as in multiple choice questions.

Divergent thinking
Divergent thinking, involves producing multiple or alternative answers from available information. It requires making unexpected combinations, recognizing the links among remote associates, transforming information into unexpected forms. The components of divergent
thinking (Guilford, 1967) (fluency, originality, abstractness of titles, elaboration and resistance to premature closure) were based on “Structure-of-Intellect model of Guilford”.

CHAPTER 2

REVIEW OF LITERATURE

Review of literature involves the systematic identification, location and analysis of documents containing information related to the research problem. The literature review provides the researcher with an opportunity to identify any gap that may exist in the body of literature and to provide rationale for how the proposed study may contribute to the existing body of the knowledge (Gay & Geoffery, 2011, pp. 80-81).

This chapter provides a review of the scholarly literature focusing on the science education; activity based teaching, creativity, achievement and attitude towards chemistry mentioned by different researchers. Further the studies that have focused on students’ comparison in creativity, achievement and attitude towards chemistry in relation to background variable such as gender. Literature on this research study is organized as follows;

2.1 Science Education

Science education is considered as a backbone for the Economic and Technological development of every country. Therefore, science education is given more importance all over the world and innovation in science education always practiced. Emphasis has always been placed on the developing scientific thinking in students through science education. Therefore, science education has always been remained a great concerned for the researchers. This section focuses on presenting different aspects of science education.

Good et al., (1985) consider science education as a “discipline” that is concerned with discovering, developing, and evaluating improved methods and materials to teach science, (p. 140). Similarly, Bailin (2002) argues that science education emphasizes on developing critical
thinking in the students that shall be contextual in nature. Such type of concepts develops a multicultural world view of scientific phenomena. Fathman, Quinn and Kessler (1992) believe that science education can lead the students to learn and understand about their physical environments in which they live and develop a multicultural world view of scientific phenomena. Rennie (2001) noted that due to science education citizens become scientifically literate by understanding their local environment, health and well-being. This concept has been further advanced by George E (2000) who says;

’Scientifically literate person is one who uses scientific concepts, process skills, and values in making everyday decisions as he interacts with other people and with his environment" and understand the interrelationships between science, technology and other facets of society, including social and economic development" (NSTA, 1971, pp. 47 - 48).

Science education improves scientific literacy, which, in turn, civilizes the society. Goodrum, Hackling and Rennie (2001) are of the opinion that science education plays an important role to improve ‘scientific literacy. Similarly Bybee (1997), Goodrum, et al., (2001) Millar and Osborne (1998), consider that scientific literacy is the goal of science education reform. Therefore, scientific Literacy is directly linked with science education that develops a civilized society.

According to George (2000) scientific literacy is the relationship between science and society, gained additional prominence when the National Science Teachers Association (NSTA) identified it as the most important goal of science. Bybee (1997) Bell et al., (2003), Bianchini and Solomon (2003) and Rascoe et al (1999) claim that scientific literacy helps the citizens in many ways. Firstly: to fulfill their personal excitement; secondly, make them to improve national economic and technological productivity; thirdly, develop their skills to resolve problems confronting the human race; fourthly, live responsible, trustworthy and reliable lives; fifthly, having to appraise the quality of scientific information; sixthly, create choices that occur every day; and seventhly having the power to involve and contribute to scientific and technological issues through public discourse and debate.
Ales (1993) identified that science education has two broad purposes, the first purpose is to promote scientific literacy among citizens on matters directly affecting their own lives and the society so that they will be able to make decisions about different issues based on information and understanding. This is essential for modern and technological society. The second purpose is to develop the technological capability by equipping with essential science-based knowledge and skills that will prepare students for scientific disciplines.

Science education is a necessary element of modern education. Because it is the building block of personal and social development and its products- advancing human society and bringing prosperity in man’s life. Nation states are judged by their scientific performance. Qudsia (2003) considers that scientific progress is possible when there is scientific knowledge and scientific skills. Science education is essential to future scientific advances and in turn, economic prosperity. Consequently, one can assign the science education, the social role of bringing progress to society, especially to the most needy of societies like Pakistan. As a developing country, Pakistan, is one of the strongest countries in the present world who have their own position in term of scientific manpower in capacity and maturity. This nation has the potentialities to understand and to create new technologies with extensive scientific inputs of indigenous origin. Qudsia (2003) considers that;

“Science education is, in a broad sense, the expected outcomes; establishing modern thinking and attitudes in the local population, providing technical training to future labor force, forming a scientific and technical basis for scientific productivity and technological innovation and through all these leading to economic development” (P.540)

Science education shares a method of discovery and a systematic knowledge that is obtained through observation and experimentation and paves the way of processing knowledge about the physical world. For this reason, science education is considered the foundation for any knowledge-based effort that improves the standard of living of human being in the shape of health, nutrition, environment, agriculture, and industry (Shah.p.19). Moreover, Science education programs are directly related with the establishment of an infrastructure of
science education. According to Ara (1998) effective science education program is directly linked with the establishment of an infrastructure for research in science education. Therefore, science education is an integral part of the solid scientific infrastructure and its importance as such as is widely acknowledged.

2.1.1 Education Policy and Science Education in Pakistan

After the emerging of an independent sovereign state of Pakistan in 1947 there was a great growing consciousness about the role of science in the service of the nation. For this purpose a National Education Commission was set up in 1958. This commission is popularly known as Sharif commission, named after its chairperson M.S.Sharif. The commission presented its report in 1959. This commission gave a strong recommendation for science education at all levels as a compulsory subject in primary and secondary education. Since then the science teaching has been included in the curriculum. Many schools and colleges were set up and the universities were considerably improved and advanced facilities were provided to educational institutions. Qudsia (2004) acknowledges that the addition of physical facilities for science in educational institutions and the prospect of good employment in scientific pursuits attracted an increasing number of students to science courses in this institution. Thus, during the sixties there has been a greater increase in the enrollment of science students specially at a higher level of education as compared to increase in enrollment of arts students. About teaching of science the commission recommended that teaching method of science should use, as far as possible, the activity or project approach and the teacher should initiate in the use of local materials as teaching aids. In the spirit of this report Second five year education plan (1960-1965) also recognized the importance of science education and training as the essential part of the socioeconomic development in the country and considered the science education at secondary stage indispensable for the skilled manpower and intelligent citizenship. The third Five Year Plan (1965-1970), having the advancement of science and technology the world over, this five year plan indicated the following basic objectives of education;

- To provide an education system that could facilitate the transition of the societies into an era of science and technology.
• To provide the youth of the country with conditions conducive to the development of their individual capacities and characters.

• To the quality of education at all levels.

This policy took greater recognition of the concept of education and specially “to stress quality in education and consolidate the program of educational research”. Just after this policy Government announced the fifth National Education Policy (1972-79). Having the importance of the science education it was suggested that integrated science courses shall be introduced at the high and intermediate level to enable the students to have a wider choice at the of entry in the higher institutions. This was a useful suggestion and the board of curriculum introduced integrated science courses

In Education Policy (1978) it was suggested that the science education would be emphasized in order to equip the students to be civilized citizens of the state. According to the National Education Policy (1998-2010) our education system must provide quality education to our children and youth to enable them to realize their individual potential and contribute to development of society and nation, creating a sense of Pakistani nationhood, the concepts of tolerance, social justice, democracy, their regional and local culture and history based on the basic ideology enunciated in the Constitution of the Islamic Republic of Pakistan.”(Ministry of Education 1998) The education policy aimed at to change the education from general to mark oriented to fulfill labor demand of the world.

Summarizing that science education is the field concerned with teaching and learning of science. Science education provides standards to develop expectations and understanding between students through the teaching of the entire course. Bailin (2002), Fathman, Quinn and Kessler, (1992), Rennie (2001) and George (2000) have an opinion which gives a new frontage that science education develops all intellectual faculties of mind; specifically, it focuses on the development of critical thinking of the students and help citizens to become scientifically literate person by understanding their locality. Bybee (1997), Millar and Osborne (1998), George (2000) Goodrum, et al. (2001) found that the main purpose of science education is to improve scientific literacy.
2.2 Studies Related to Activity Based Teaching

There are mixed findings of different researches about the activity based teaching. Mishra and Yadav (2013) conducted a study on the Effect of activity based approach on achievement in Science of students at the elementary stage. Sixty students of class VII were taken as a sample. It was concluded that activity based teaching is an effective approach for all around development of children at the elementary level. Another study was conducted by Faiza, et al (2012) on the impact of activity-based teaching on students’ academic achievements in physics at secondary level taking 50 students as a sample. It was concluded that the activity-based teaching is more effective for the development of higher order skills in the students. A similar study was conducted by Shah and Rahat (2014) to find out the effectiveness of the activity base teaching method on the learning of science students. 50 students were taken as a sample. It was concluded that Activity-based learning, teaching method generated an ideal situation for science teaching especially at Elementary level. In activity-based teaching methods, learners were involved actively in hands-on minds on experiences and acquire an opportunity to relate intangible concepts and theories with actual observations. Similarly, it was concluded in Lowenstein (2002) that Activity-Based teaching Strategy made students active participants, aids retention of materials learnt, builds confidence, helps students maximize their potential and favor intrinsic motivation.

Edward (2001), Harfield, Davies and Kenley (2007) in their conducted studies reached at the conclusion that the stress on active based teaching over traditional methods of teaching was due to two points i.e. the active role of students and collaboration among students. It was concluded in a study conducted by Mari (2001) in activity based method, the students worked in a friendly manner, gladly with motivating spirit as active throughout the whole lesson even to an uninteresting topic/work. Similarly, Suydam, Marilyn and Higgins (1977) concluded that activity based learning is the learning process in which a student is actively involved in doing or in seeing something done.

Hussain, et al. (2011) conducted a study on effect of peer group activity-based learning on students' academic achievement in physics at the secondary level. 88 science students of 10th class were divided into two equal groups (n=44) named as the experimental group and a control group. It was concluded that for the teaching of physics at a secondary level activity
based learning is more effective as compared to traditional methods of teaching. Boud and Feletti (1999) suggest that activities based learning encourages students “to learn how to learn” through different activities and real-life problems. According to Churchill (2003) activity based learning (ABL) helps learners to construct mental models that allow for 'higher-order' performance, such as applied problem solving and transfer of information and skills.

Another study was conducted by Subramonian and Prabha (2014) on learning ability in elementary school mathematics based on ABL (Activity Based Learning) approach. The sample consisted of 1042 students from 4th and 5th standard. It was concluded that the ABL (Activity Based Learning) method is suited to the students in understanding mathematical concepts at the school level.

Prince (2004) conducted a study to examine the evidence for the effectiveness of active learning. It was concluded that activity based learning (ABL) was a learning method in which students are engaged in the learning processes. Learning activities if based on “real life experience” help learners to transform knowledge or information into their personal knowledge which they can apply in different situations. Similarly, Mastropieri and Scruggs (1995) concluded in his study that an activity based learning seeks to promote learning by providing students with experiences that allow them to discover and experiment with science. Through discovery and inquiry, teachers involve students in creating and expanding their knowledge and understanding about the content area being studied.

Chemistry teaching is an activity based approach that supports both theoretical and practical works in the laboratory. Chemistry laboratory is a unique place of instruction and a learning environment where students work collectively and cooperatively alone or in small groups. According to Hofstein, Levy and Shore (2001), Lazarowitz and Tamir (1994) chemistry laboratory is a unique mode of instruction and a learning environment in which the students work cooperatively and collectively in small groups to examine a scientific phenomena. When properly developed, laboratory activities have the potential to enhance students’ achievement, conceptual understanding and understanding the nature of science as well as their positive attitudes and cognitive. Similarly, in the words of Azizoğlu and Uzuntiryaki (2006) chemistry is a science based on experimentation, doing an experiment in a laboratory is an important part of learning chemistry. Besides, in order to develop interest, curiosity, positive attitudes toward
chemistry, creativity, and problem solving ability in science and to improve students' understanding of science concepts and scientific processes, laboratories are essential.

A study was conducted by Duvarc (2010) to observe the students’ understanding of “Elements and Compounds” unit which is taught through the use of several activities such as card activity. The study was implemented in one 9th grade classroom. The students found the activities, entertaining and helpful for remembering the subjects. The results are also very remarkable for teachers who are open to use new methods or activities in their teaching.

A study was conducted by Sim, Seng and Ngaini (2007) in Chemistry via Carnival: An Activity Based Approach in Learning Chemistry. The active learning oriented activities include hands-on experiments, quiz, poster and mini lectures were used to educate the school students some basic chemistry relating to daily life. 300 students attended the activities. Observations and questionnaires were used as the instruments to describe and measure the learning, experiencing these, hands-on experiments were found to be the most effective approach; more than 86% of the participants agree that they have learnt well from this peer mentoring and collaborative learning strategy. Activity based learning is an effective approach; however, it needs to be carefully constructed to achieve the learning outcomes.

Similarly, another study was conducted by Sanghani (2014) on An Activity- Based Approach in Learning “Polymer Chemistry”. The students found the activity learning helpful for achieving learning outcomes. The results were also remarkable for a teacher who is open to use new activity based methods or activities in their teaching.

To conclude this section, activity-based teaching plays an important role in learning. It has the potential to promote scientific skills which are essential in learning science, and also motivate students to enjoy learning science. Mishra and Yadav (2013), Faiza, et al (2012), Shah and Rahat (2014), Lowenstein (2002), Edward (2001), Harfield, Davies and Kenley (2007), Mari (2001), Suydam, Marilyn and Higgins (1977) have discussed the effectiveness of the activity base teaching method on the learning of science students, while Hussain, et al. (2011), Boud and Feletti (1999), Churchill (2003), Subramonian and Prabha (2014), Prince (2004), Mastropieri and Scruggs (1995), have discussed activity based learning. Some researchers such as Hofstein, Levy and

2.2.1 Studies Related to Activities with Low Cost Materials

Activities/experiments are important for active learning of the students, but cannot be denied that these involve high cost/expenditure as most of the schools do not have well-equipped science laboratories. According to Khitab (2004) “most of the schools do not have separate chemistry laboratories and those having chemistry laboratories are not well equipped. However, it is certainly possible to design low cost activities and experiments using easily available materials to chemistry” (p. 13) According to Shafiq (Personal communication, March 2010) the use of those materials found around us as used and thrown away garbage, in science laboratories in an education institution is called low cost materials. Those activities which are performed in science laboratories with the help of low cost apparatus are called low cost activities. Low cost apparatus increases the capacity to observe. Yitbarek (2012) believes that teaching through activities with low cost material increased the capacity of the learners to observe, explain and do real science. He further added that low cost apparatus from locally available material comparatively offered an alternative solution to do activities in classrooms under difficult financial constraints. Similarly Ara (1998) stresses on the use of apparatus fabricated of low cost materials for the teaching of chemistry at the secondary level. She is of the opinion that for the development of scientific skills; illustration and provision of opportunities for scientific investigation the use of low cost materials are equally effective.

According to Mishra and Yadav (2013) most of schools cannot afford well equipped science laboratories. However, it is certainly possible to design low cost activities and experiments easily available materials. Researchers are of the opinion that there should be a shifting from expensive apparatus to low cost apparatus. As Tilahun, et al (2011) indicated that the majority of the school laboratory had the shortage of apparatus. The unavailability of adequate equipment in the chemistry laboratories is a major problem which is of serious future concern, therefore, a need for efforts to provide more for low cost apparatus than high cost apparatus by utilizing locally available resources.
Usman (2000) endorsed the poor performance of students in science concepts to rote learning. This, according to him is as a result of non-exposure of students to activities in their classes due to lack of science teaching facilities. However, Adeniyi (1997) and David (2007) agreed that though science teaching facilities are necessary, but many teachers of science are ill equipped and ill-prepared to guide students towards inquiry. They seem to find activity-oriented instruction difficult to manage.

According to Ali and Papaiah (2015) “Sometimes the standard teaching aids may remain out of reach – may be due to any reason. Look around, quit possible one gets something from the surrounding, which may serve as a better teaching aid for the topic. A step further, perhaps he who is innovative, may prepare such an aid for the available materials from here and there, low cost-no cost teaching material is the term that refers to an offhand construction of a teaching aid with simple available materials costing little or nil. No-cost teaching material is mater is that which a teacher can use by carrying it from local sources. It may waist things which a teacher can use as a teaching aid. Low-cost teaching aids can be used in nursery, primary, middle, secondary and senior secondary schools” (p. 3)

A study was conducted by Sivakumar (2016) to find out the effectiveness of low cost teaching aids in teaching science. The sample consisted of 40 students in Control group and 40 students in Experimental group. It was concluded that the achievement scores of Experimental group Students were higher than the Control group Students. Teaching by using low cost teaching aids is more effective.

Another study was conducted by Khitab (2012) on the Development of Low Cost Learning Material for the teaching of Chemistry at Secondary Level. The sample consisted of 10 secondary school teachers and 100 students of class 10th. It was concluded. It was concluded that none of the science teachers could construct low cost material for the teaching of chemistry at the secondary level.

A similar study was conducted by Ali and Papaiah (2015) on Learning by doing and Innovative use of low cost/no cost teaching learning materials. It was concluded that there was a less availability of low cost/ no cost teaching material in elementary schools for the teaching
of science. However, to some extent there was the availability of ready made teaching material, few teachers buy low cost/ no cost teaching material personally, funds are not much sufficient, only some school has science kits. Availability of science of raw material was not satisfactory. Moreover, 50% teachers did not prepare and utilize low cost/no cost teaching material in elementary schools which was a pathetic scenario.

A study was conducted by Singh and Kaur (2012) to investigate the use of low cost-no cast teaching material by elementary school teachers in teaching of science. 50 government elementary schools were taken as a sample. It was concluded that there was below average usability of low cost/ no cost teaching material in elementary schools in the teaching of science. Low cost/ no cost teaching material is not used for every topic by teachers, it demands extra time to plan a lesson and it was very time consuming.

Summarizing that most of the studies have discussed the importance of low cost material in laboratories to conduct practical in detail, e.g. Ara (1998) and Yitbarek (2012) have mentioned that teaching through activities with low cost material increased the capacity of the learners to observe, explain and do real science while Khitab (2004), Tilahun, et al (2011), Mishra and Yadav (2013) pointed out that most of the schools do not have well equipped chemistry laboratories. Ali & Papaiah (2015) and Shafiq (2010) stress on the use of low cost apparatus to conduct practical work in science laboratories.

2.2.2 Present Status of the Development of Low Cost Material in Pakistan

To improve the quality of education Government of Pakistan has taken steps regularly. Many workshops and refresher courses are being arranged. Ghaffar (1995) states that Audio-visual and Leader education unit of the curriculum wing, ministry of education has been planning and designing National teaching kits in the spirit of education policy 1972 -1980, which envisages a variety of measures to be taken to improve the existing facilities, methods of teaching, provision of the instructional material and teaching aids of the primary education.

Although the National Education Equipment Centre (NEEC) has been designing, developing and supplying equipments to schools and colleges, but the application of low cost
material is its main concern. According to Farid (2002) the introduction of teaching kits into the schools and colleges curriculum is one of the main goals of (NEEC). For this purpose, the curriculum wing of Ministry of education conducted periodic workshops for master trainers who in turn train classroom teachers.” Similarly the Institute of the Promotion of Science Education and Training (IPSET) Ministry of Education sponsored various projects on activities with low cost material in chemistry physics and Biology. Slimming (1994) reported that IPSET had completed a research project “Monitoring and Evaluation” the purpose resources for the teaching of science subjects.

The unavailability of adequate science equipment is a great problem not only for Pakistan but for the third world countries as well. According to Ara (1998) APEID (Asian Program of Educational Innovation for Development) initiated on the recommendation of the third regional conference of the Ministry of education and those responsible for economic planning in Asia (May- June 1971, Singapore) and the authorization of general conference of UNESCO at its eleventh session, Paris 1971 aimed at stimulating and encouraging educational innovations linked to the problems of national development in the region.

Pakistan was one of the member countries of APEID. Just like other member countries of APEID Pakistan had also its national policy about teaching of science with Low Cost teaching materials. Many national and international projects such as Science Education Project Phase-1 (SEP-1) and SEP-II (2001) assisted by Asian Development were launched. Many workshops and refresher courses were arranged to assess the teachers to fabricate low cost activities for the teaching of science subjects. Apart from SEP- II, current project on US-Aid also helping high and higher secondary school teachers in fabrication of low cost material and providing low cost material kits to high schools. But it is amazing that teachers in primary and high schools are getting no attention by this project.

2.3 Studied Related to Creativity

This section focuses on every aspect of creativity, such as definitions; theories and measurement tools are being discussed.
2.3.1 Definitions of creativity

Creativity is a complex construct and it is one of the constructs that is not well defined and therefore, no universal definition can be found. However, Rhodes (1961) classified the definitions of creativity into three dimensions: definitions involving the person, definitions involving the process, and definitions involving the product and press or environment. Similarly, Williams (1990) gives three main categories for the definitions of creativity: person quality, personality, way of life. (E.g. Defining a creative person as one who can tolerate ambiguity); creative products - their unique features (e.g. Defining a creative product as one that is qualitatively different from other products of the same type creative processes - their basic cognitive elements.

Cropley (1999) considers creativity as a social phenomenon that is facilitated by some social factors and inhibited by others. Cropley (1999) further adds creativity to the individual level as “an aspect of thinking, as a personality constellation, and as an interaction between thinking, personal properties, and motivation” (p. 511).

Torrance (1962) defines creativity as “the process of sensing gaps or disturbing, missing elements; forming ideas or hypotheses concerning them; testing these hypotheses; and communicating the results, possibly modifying and retesting the hypotheses” (p. 16). Similarly, Vernon (1989) believed that creativity is the person’s ability to generate ideas, inventions, artistic objects, insights, and products that are judged by experts as being of high scientific, social, aesthetic, or technological value. Similarly, Robert (1982) considers that creativity is the tendency to generate or recognize ideas. Creative men have the possibilities to solve problems, communicating and entertaining ourselves and others. MacKinnon (1978) is also of the opinion that creativity is the capability of persons to generate new ideas that contribute substantially to an intellectual domain.
Storr (1991) states that creativity is the ability to bring to light something new which were not exist before. Similarly, Hu and Adey (2002) have the idea of creativity in the sense of creating original solutions and new understanding.

According to Feldhusen and Goh (1995) creativity is parallel construct of intelligence; however creativity is not restricted to behavior like intelligence that is restricted to cognitive or intellectual functioning.

Creativity is essential for problem solving in daily life. Creativity gives a creative person who imagines a variety of routes to solve and gives a new understanding as Lubart (1994), Sternberg and Lubart (1999) reached to conclusion that creativity is essential on both the individual and societal levels. For the individual level, creativity is important when an individual uses problem solving at work or daily life. For the societal level, creativity results in scientific discoveries and new artistic achievements’. For such type an achievement a creative person is required.

Williams (1990) defines a creative person as one who can tolerate ambiguity. It is the student in education system that uncovers the discoveries. In the opinion of Hu and Adey (2002) problem solving in science requires a student to explore his/her own repertoire, to imagine a variety of routes to a solution. This is the justification for considering scientific creativity as worthy of attention in the education of students who will either become scientists or who need an understanding of society.

Guilford (1950) defines creativity as a group of traits that characterizes creative persons. The researcher proposed that creativity involves problem finding and evaluative ability.

Creativity has got a base for research as argued by many researchers such as (Isaksen as cited in Firestien, 1993) introduced the concept of the 4P’s (person, process, product, press (environment) of creativity as circles that overlap and this approach has been a base for most research on creativity. Vernon (1989) concluded that creativity consists of a variety of personality factors, environmental conditions, chance factors, and even products.

Autun (2004) mentions that the creative process involves a number of components, most commonly: imagination, originality (the ability to come up with ideas and products that
are new and unusual), productivity (the ability to generate a variety of different ideas through divergent thinking), problem solving (application of knowledge and imagination to a given situation), the ability to produce an outcome of value and worth.

Creativity, domain and various skills are interrelated. Mohamed (2006) has quoted Anabile (1983) that Domain-relevant 37 skills entail the knowledge about the domain, technical skills, and specific talents related to the domain. Creativity-relevant skills involve working styles, thinking styles, and personality traits. Task motivation entails the aspiration to accomplish something for its own sake.

In conclusion, the concept of creativity has been used frequently in various fields of study with different meanings. According to Torrance (1962), Vernon (1989), Robert (1982) and MacKinnon (1978) creativity is the ability to generate ideas, digging deeper into ideas, openness, and courage to explore ideas and listening to one's inner voice. It is an open exploration or search for ideas in which one generates many ideas (fluency in thinking) varied ideas and new perspective (flexibility) and unusual or novel ideas (originality) while Williams (1990) and Autun (2004) involved a number of components in creating. All these definitions have been welcomed as giving recognition to the importance of creativity and the role of education in encouraging creative development.

2.3.2 Theories of creativity

Several psychological theories of creativity have been chronicled. Some of them are given below.

2.3.2.1 de Bono’s Theory: Creativity as Lateral Thinking

This theory is based on the process of breaking out every day design of having an effect to the input ideas. In other words, do Bono (1968) describe that thinking process progresses outside habitual channels of thinking. He further argued that these channels are shaped, just like the water shapes land. Similarly incoming information tends to deepen the mind-channels. The mind-channels, direct the flow of incoming information so as to associate different contents. Thinking about one thing naturally invokes is thought about another.

Horowitz (1999) quoted de Bono (1968) as;
“Mind is a self organizing system. He explains this as routine thinking occurs when one’s thoughts are allowed to drift in existing channels. Creative thinking, on the other hand, occurs when thoughts are directed or when they accidentally drift laterally across channels. When this occurs, it results in what we frequently call surprising ideas. de Bono suggested that enhancing creative thinking is provocation. The role of provocation is to deflect thinking from current channel to other channels. As an example for provocation de Bono suggests thinking about square ‘wheels’ for cars, when trying to think about the possible benefits.”(p. 15)

Creative ideas are formed by connecting two or more previously within one's knowledge, but unconnected, pieces of content. de Bono said that every idea must be reasoning in hindsight, and therefore must be connected to the existing, well-established system of channels.

2.3.2.2 Guilford’s Theory: Creativity as Divergent Thinking

This theory is based on the relationship between diverging thinking and creativity. Guilford mentioned that divergent thinking is the ability to produce a diversity of responses to an open-ended problem. Guilford (1959) claims that diverting creativity (development of numerous ideas) is essential for creativity, That is why diverging thinking has been the past 55 years to assess the creative potential of individuals.

In the course of problem solving, Guilford hypothesized; a creative individual first uses the divergent thinking, in order to “diverge” from what is known to original ideas. And then uses convergent thinking, the logical mode of thought, to converge on a single solution, or idea.

For evaluating a test he believed that four measures; (i) fluency, (ii) flexibility (iii) originality (iv), elaboration is sufficient for the creativity measurement. Presently diverging thinking is widely accepted process of creativity, particularly with young children.

2.3.2.3 Mednick’s Theory: Creativity as Remote Associations

The basic elements of this theory are ideas, or other meaningful cognitive. The most important concept of Mednick’s theory is associative hierarchy: the way an individual's
association is organized. Mednick (1962) explains this theory in such words that creative individuals are capable to have a flat hierarchy, which carries the meaning of connection of elements to many others. For instance, less creative ones will have steep hierarchies in which each element evokes very few other elements. According to Mednick (1962) there are three mechanisms, serendipity -a chance event stimulates two elements; similarity -the two associative elements, or the stimuli that evoked these elements, are similar; and meditation of common elements, typically through the use of symbols. Mednick (1962) developed the Remote Association Test to assess an individual hierarchy structure. This test is known as RAT.

2.3.2.4 Newell and Simon’s Theory: Creativity as Search

This theory is based on two kinds of channels; a sensory channel and motor channel. Newel and Simon (1972) connected cognitive system as a goal seeking system connected to the outside environment through these two kinds of channels. Through sensory channel it receives information and through motor channel it acts on the environment. Both kinds of information are stored in system of memory. Owing to mechanism of system Newel and Simon (1972) developed Means –Ends Analysis model of cognition and the construction of the GPS computer program that simulates human problem solving based on the Means-Ends analysis model. On the basis of the model they have explained their creativity theory and added that GPS is a system that searches to discover and assemble sequences of actions that will lead it from a given situation to a desired situation.

2.3.2.5 Lenat’s Theory Creativity as Heuristic Search with criteria for interestingness

This theory is based on a model called “Accretion Model of Theory Formation”. The main theme of this theory is that “creativity is a heuristic search,” which account for many cognitive activities including creative problem solving. In his study Lenat (1978) stated;

“Heuristic search can account for many cognitive activities including creative problem-solving: “It turns out that we can model a surprising variety of cognitive activities (recognizing, problem solving, inventing) as search in which the performer is guided by a large collection of informal ‘rules of thumb’ which we shall call heuristics or heuristic rules” (P. 262).
According to Lenat (1978) several computer programs use heuristic search to arrive at innovative solutions or concepts. For example, DENDRAL a heuristic-based computer program aimed at enumerating atom-bond graphs of organic molecules developed by Feigenbaum and Buchanan (1977). The EURISKO research program is built on the hope that heuristics can help at this meta-level as well, help in building and extending and testing new heuristics. With this a set of large number of concepts of set theories investigated.

2.3.2.6. Perkins’s Theory: Creativity as a Search in a “Klondike space”

Perkins (1995) who states that creative process is a research through a space of possibilities to attain end-states called resolutions.

In 1897 a mass migration of people had occurred to North West Canada in search of gold. Perkins allegorically likens search in a space of possibilities to searching for gold in the Klondike. He stated the fundamental principle as;

‘Gold is where you find it’

Therefore, the most investigative approach of search in a Klondike space is to start at a certain point, test some points around it, and then move in the direction of the highest payoff. African intelligence researchers called these strategies as Hill-climbing strategies. On the bases of Hill-climbing strategies Perkins mentioned four regions of problem space. According to Perkins (1995) creative ideas are likely to be found. The four problems are: (1) the rarity problem, a research place where the resolutions are very rare among the possibilities, (2) the isolation problem; when the resolution lie in another possibility space, (3) the oasis problem; a region of the problem space where search lingers in areas close to success but not quite there, (4) the plateau problem; this problem arises in large regions of a search space with promising directions of search.

Perkins mentioned the different strategies which researchers can use to tackle the four problems. These strategies are; the rarity problem; this problem is solved when the researchers used to automate search (mechanized search), working in groups, the use of investigative approach to problem solving. The isolation problem; this problem can be solved by searching through nonviable; here the researchers deliberately open themselves to get new information.
The oasis problem; this problem can be solved when the researcher changing the point of entry.

The plateau problem; this problem can be solved when the researcher identifies new boundaries of the plateau.

2.3.2.7 Hofstadter’s Theory: Creativity as Variations on a Theme

Hofstadter (1985) theory is based on a distinction between an object and a mind’s concept of the object and has given the idea of metaphor of a ‘knobbed machine. Hofstadter considered created as a mechanism that supports the making of variations on a theme by changing the setting of the knobs. Creativity ‘enjoys’ the fact that concepts have a natural tendency of “slipping” from one into another, following an unpredictable path. Creativity is a result of variation on the theme.

2.3.2.8 Componential Theory of Creativity

According to Amabile (2013) this theory is a comprehensive model of the social and psychological components necessary for an individual to produce creative work. According to this theory, for any creative response four elements are necessary: three elements—domain relevant skills, creativity-relevant processes, and intrinsic task motivation that are within the individual and the fourth element, IE, social environment is outside the individual in which he/she is working. According to Amabile (2013), the level of creativity that a person produces at any given point in time is a function of the creativity components operating, at that time, within and around that person. According to John (2013) and Amabile’s (1996) theory identifies three components or aspects necessary for creativity, while Urban’s (1991) componential model of creativity identifies six components of human activity necessary for creativity. The components are grouped into two main areas of human activity:

<table>
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<tr>
<th>Cognitive or knowledge and thinking components</th>
<th>Personality or motivational and emotional components</th>
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• Having a high level knowledge and skills of a specific topic area
• Being able to think divergently about the topic
• Having a well developed general knowledge and thinking base

• Having a high level focusing and task commitment
• Having high intrinsic motivation and motives
• Being ‘open’ about the topic and prepared to tolerate ambiguity in the area.

In conclusion, theorists’ such as the Bono (1968) Guilford (1959) and Perkins (1995) agreed that diverting creativity (development of numerous ideas) is essential for creativity, while Mednick (1962), Newel and Simon (1972), Lenat (1978), Hofstadter (1985) and Amabile (2013) involved a number of components, most commonly: imagination, originality, problem solving, fluency and the ability to produce an outcome of value and worth.

2.3.3 Research Regarding Creativity

Developing creativity of the students has remained one of the primary goals of teaching learning process. But there is a little recent research, it seems, investigating the development of creativity in education, although some commentators suggest that creativity can be learned and developed. Seltzer and Bentley (1999) suggest in their recommendations on knowledge and skills for the new economy, that "creativity can be learned and that the school curriculum should be restructured ‘to reflect forms of learning which develop creative ability" (p.10).

Hilal and Omer (2008) investigated the effect of teaching science process skills education to promote the scientific creativity, attitude toward science and achievement in science. The subjects of the research consist of 40 students reading at 7th grade of an elementary school. It was concluded that the students having scientific process skills, increased the academic achievement and improved the student’s creativity in science.

Another study was conducted by Gangadharrao and Marathwada (2012) to explore scientific creativity of students in secondary school. One school was chosen by non-purposive method out of normal (average) schools and 1 Navodaya school was selected by the purposive method of sampling. Afterwards, out of 207 students of Std. 9th, 100 students were selected by
lottery method by choosing 50 students from each school. It was concluded that the level of fluency, flexibility and originality factors of Navodaya school is better than that of average schools.

Upahi (2012) concluded in his study that the degree of teachers’ professional level in promoting problem solving and decision making teaching and its impact on student gains, as well as the number of teachers collaborating together in the teaching within a school, had a significant impact on their students’ improvement in skills associated with social-scientific reasoning and scientific creativity. Similarly, Shukla and Sharma (1987) concluded in their studies that urban students were higher in all aspects of scientific creativity.

A study was conducted by Ramirez and Ganaden (2008) on Creative Activities and Students’ Higher Order Thinking Skills. Sixty (60) students were assigned randomly into Instruction with Creative Activities (ICA) group and Instruction with No Creative Activities (INCA) group. Various creative activities were incorporated into fourteen lessons of the ICA group in the intervention which lasted for ten weeks. The group exposed to the ICA was expected to have a higher mean score on the Chemistry Test for Higher Order Thinking Skills (Chem. THOTS). However, no significant difference was found between the mean posttest scores of the ICA and INCA in the ChemTHOTS. Moreover, no significant difference was found between the mean gain score from pretest to posttest of the two groups.

Tomasevic and Trivic (2014) conducted a study to find out the view of Serbian chemistry teachers (N = 334). They concluded that the majority of the teachers promoting creativity through teaching chemistry. Most of the teachers stated that their teaching practice contained activities that are conducive to stimulating creativity (85.7%). Some of the teachers stated that the potential for stimulating creativity is to be found in laboratory work (34.1%). To stimulate creativity among students, most teachers indicated that examples of laboratory tasks and criteria to evaluate students' work would be helpful. In order to stimulate creativity, the teachers require additional information related to the set up of laboratory work and criteria for the evaluation of students' activities and products.

2.3.4 Studies Related to the Development of Creativity Test
Suitable tools pave the way for successful accomplishment of the objectives of any research program. Therefore, many tools have been developed by researchers. This section focuses on tools developed for creativity measurement.

Muhammad (2006) developed and validated scientific creativity test for fifth grade students on the basis of previous developed creativity tests. The constructed test was consisted of four components i.e., Fluency, Flexibility, Originality, and Complexity. The reliability analysis of test showed that the Scientific Creativity Test had a .89 coefficient as a consistency of scores. Philip (2008) had constructed a test to measure the scientific creativity of higher secondary students on the base of components, i.e., fluency, flexibility, originality, elaboration and redefinition and sensitivity to the problem identified by Philip (2008) The contents for the construction of tests were based on the scientific awareness that were expected from higher from higher secondary school students.

Liang (2002) in his study the researcher used the Test of Divergent Thinking, Creativity Rating Scale Creative Activities and Accomplishments Checklist - The Nature of Scientific Knowledge Scale - Science Attitudes Scale for 130 male 11th graders in three biology classes, Sansanwal and Sharma (1993) have used Majumdar Scientific Creativity Test for their studies. Sinha and Singh (1987) used the Test of scientific creativity consisting of 84 items for 54 Secondary school students. The researcher made analysis on the basis of Item analysis, Difficulty value, Discrimination value, test-retest, split-half, and KR-20, content and Criterion validity. Xinfa, Chongde and Herbert (2008), developed a scale (development of the Beijing Test of Creative Thinking (BTCT), which was designed to measure verbal and figural creativity; The BTCT consisted of two subtests – Verbal subtest and Figural subtest - and each subtest has one item.

Torrance Test of creativity was presented by Eveline (2006) and for scoring gave 5 norms referenced measures. (1) Fluency (2) Originality (3) ABS trances of title (4) Resistance to premature closing (5) Elaboration. Guilford (1967) presented the intellectual factors of creativity on his investigations. These are: (i) Fluency (word fluency, ideyyational fluency, associational fluency and expression fluency) (ii) Flexibility (spontaneous flexibility and adoptive
flexibility) (iii) Originality (iv) Elaboration (v) Redefinition (vi) Sensitivity to the problems. The flow sheet diagram of the creativity test is given below.

(Besemer and O'Quin( 1987) and Taylor (1975) have given various dimensions to assess the creativity. The dimensions covered by the two scales are as follows:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Thinkers</th>
<th>Aspects</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Inventories</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Besemer and O,Quin (1987)</td>
<td>Creative Product Semantic Scale</td>
<td>Novelty (product is original, surprising and germinal), Resolution (product is valuable, logical, useful, understandable), Elaboration and Synthesis (product is organic, elegant, complex, well-crafted)</td>
</tr>
</tbody>
</table>

Besemer and O'Quin (1987) scale measures the three dimensions with high reliabilities. The range of this reliability is 0.69 to 0.87.

A hypothetical model of casual technical creativity was given by Hany (1994) for the development of basic cognitive components of technical creativity, a longitudinal comparison of children and average intelligence.

Philip (2008) has summarized factors and tasks of Guilford's theory concerning the measurement of creative thinking abilities; (See Appendix –D) (Factors, Tests and Descriptions of Guilford's Creativity Test)

Summarizing, the selection of tools for a particular study depends mostly on the availability of these tools appropriate for the purpose under consideration. Muhammad (2006), Philip (2008), Sansanwal and Sharma (1993), Liang (2002), Sinha and Singh (1987), Taylor, (1975), Besemer and O, Quin (1987), Hany (1994) and Philip (2008) developed creativity tests. Most of the available tests on Scientific Creativity have incorporated divergent items.
2.3.5 Gender Related Research in Creativity

The definitions of the creativity evolve to become more multi-faceted therefore; many studies have been conducted on the subject of creativity in relation to gender.

Mohamad (2006) conducted a study to investigate the scientific creativity of the fifth grade students. A related purpose was to investigate the gender differences in scientific creativity. The researcher concluded that female students had better scientific creativity than male.

In contrast, in many researches males were found more creative than female. Smritikana (2013) conducted a study to find out the gender in creativity among school students, 100 school students (50 boys & 50 girls) 9th and 10th classes were taken as a sample. The test consists of 32 items covering a dimension of creative production, fluency, original power, flexibility and ingenious solute on of problems. The result showed that there was a significant difference between boys and girls on creativity favored male students more creative than female students.

Similarly, Stolitzfus, Nibbelink, Vredenburg, and Thyrum (2011) used the Torrance Test of Creative Thinking (TTCT; Torrance, 1974) as an approach to evaluate creativity in undergraduate students. Using a sample of Turkish University students, found male students’ performance on creativity was better than that of females.

However, some studies showed that there was no gender wise significant difference as a study conducted by Brkul (2008) showed that there was no significant gender difference in students’ creative thinking ability. Similarly, Shukla and Sharma (1986) found no significant differences between boys and girls in scientific creativity.

2.4 Studies Related to Achievement in Chemistry

One of the main objectives of science education is to develop students' understanding for better performance and achievement and to make students learn concepts meaningfully. In the words of Zaman (2011), achievement is the act of achieving or successful performance, in other words, an accomplishment of assigning tasks. According to Philip (2008) achievement is performance in science of the students in the group under consideration for the annual
examination. The variable achievement in Science as used in the studies measure the important curricular outcomes of science subject. The achievement levels of students are expressed in terms of total scores obtained for Physics and Chemistry in the annual examination.

Many researchers conducted studies related to achievement in chemistry such as Demircioglu and Ayas (2005) conducted a study to investigate the effects on students’ achievement and misconceptions of new teaching material developed for the unit. Acids and bases. The researcher took eighty students as a sample and the research was carried out with an experimental/control group design. The researcher used the Concept Achievement Test. The results from the post-tests indicated that the students in the experimental group, taught with the new teaching material, showed significantly greater achievement in the unit than did the students in the control group. Another study was conducted by Khitab (2004) on the causes of poor achievement of science students in the subject of chemistry at the secondary level. It was concluded that poor achievement of science students in chemistry was due to the non-availability of well equipped science laboratories, the bulky test book of chemistry, leaking of logical contents and difficult to understand chemistry content as well. Similarly, Ezeano (2002) reported that the poor achievement in chemistry, in external examinations, was caused by lack of inadequate laboratory materials. Twoli, (1986) and Orodho, (1996) identified in research studies that the lack of adequate instructional resources and equipment, poor teacher preparation and remuneration are the main reasons of poor achievement of chemistry.

Yildirim et al., (2010) conducted a study on the effect of analogy and laboratory based instructions on student achievement about chemical equilibrium in comparison with traditional instruction. The sample was composed of 65 students from a high school in Trabzon. It was conducted that Laboratory based Teacher Guidance Materials (LBGM) increased student achievement about the concept better than the students in the group instructed with an analogy based traditional education. This result refreshes the importance of laboratory based activities for chemistry course.

Another study was conducted by Pauline (2012) to investigate the effects of activity-Based teaching strategy for academic achievement and retention of Basic Science concepts among junior secondary two students. A sample of 80 JS 2 Basic Science students were
randomly selected made up of 37 male and 43 female, pre-tested and categorized into experimental and control groups. It was concluded that activity-based instructional strategy enhanced the student academic achievement and retention among JSS2 students.

Similarly, Mishra and Yadav (2013) conducted a study on Activity Based Approach enhance achievement in sciences of class-VII students. Activity Based Approach consisted of different activities for the all around development of children at the elementary level. Activity should be prepared with low cost material which is available in the locality. It was concluded that Activity Based Approach is significantly more effective than the traditional approach of teaching.

Another study was conducted by Kalaivani and Babu (2011) to investigate the Higher Secondary School Students’ achievement in chemistry in relation to their study Habits at various schools. The sample consisted of 565 higher secondary school students. The researchers used Gopal, (1976) study habit scale and their final examination marks were considered for achievement score. Independent samples T test for differences were performed across three distinct groups, that is, Gender, Locality and Type of school. The results of test indicated that there was a positive and significant correlation between study habits and Achievement in chemistry. However, they found no significant difference in the study habits of higher Secondary students in respect of gender and type of school.

Tezcan and Uzun (2007) conducted a study to compare the high school students’ achievement on the unit of “Elements and Compounds” using the cooperative learning and traditional learning. It is found that those students who were taught through cooperative learning method have higher levels of achievement in contrast to those receiving traditional one.

Oginni et al. (2013) conducted a study on School Factors as Correlates of Students’ Achievement in Chemistry. The investigator concluded that a student’s achievement, school location, laboratory adequacy and frequency of practical classes were predictors as they have significant effects on the academic achievement of chemistry students especially at secondary school level. School type was found to have a significant effect on students’ achievement in chemistry. Similarly, Kelly (1978) and Khitab (2004) are of the opinion that the availability of resources such as textbooks, laboratory equipments and materials, for both teaching and
learning, helps student achievement and better performance in chemistry. Science teachers, on the other hands, have their role in teaching chemistry and no one will doubt their influence on their students’ acquisition of knowledge and skills. The qualification, teaching experience and instruction styles will therefore have an influence on performance in Chemistry.

Many research studies on students’ achievement in learning are available. However, it is very significant to note that no study has been done to find out the impact of teaching chemistry through activities with low cost materials on student achievement in chemistry at higher secondary level. Therefore, a further study on higher level might be added to the literature of science education.

2.5 Studies related to gender differences in achievement of chemistry

In all developing countries sciences education is being called upon to play an even more important role in the future. More students are needed to become competent in the key science subjects of physics, chemistry, and biology. For an all round contribution, there is a need to involve both men and women. This section focused on gender differences in students’ achievement in Secondary School chemistry.

A study was conducted by Busolo (2010) on gender differences in students’ achievement in chemistry in secondary schools. The study revealed that gender was strongly associated with Chemistry achievement ($r = 0.9880, \alpha > 0.001$). As a result, boys’ schools performed better than girls' schools. Nwosu and Okeke (1995), Alexo Ponlou (1997), Okpala and Onocha (1998) and Adeoye (2000) who found that there was gender difference in favor of boys in relation to practical skills in science.

Njoku (2002) in a study investigated the enhancement of girls’ achievement of Chemistry practical skills in co-educational schools. The study revealed that scores in practical skills depend on sex, as boys in mixed schools dominated girls with the skills of apparatus manipulation, conduct of experiments, control of variables as well as in mathematical and computational skills. Girls in single sex schools performed better than their male counterparts in mixed schools.

Shaibu and Mari’s (1997) study on gender difference in acquisition of science practical skills among Junior Secondary School students in Nigeria showed that there was a significant
difference in the practical skills of boys and girls, but no significant difference was observed in the performance of boys and girls in the application of practical skills acquired. The students were reported to possess a low understanding of science process skills while female students were significantly better in their understanding of science process skills than their male counterparts. There was also a significant difference between male and female students with the ability to solve problems requiring their understanding of the process skills. The female was better than a male.

Ogunkola and Bilesanmi (2000) carried out a research on the effectiveness of laboratory-based and conventional lecture methods on students’ achievement in Biology and found that students’ achievement in Biology was not sensitive to the sex of students. The results revealed no significant gender-related differences. However, females achieved slightly higher grades than males.

In contrast, Raimi (2002) reported that the effect of gender on students’ achievement in Chemistry Practical skills acquisition was not significant. He also found that there was no significant interaction effect of treatment and gender on students ‘acquisition of practical skills in Chemistry. The female students were also reported to have performed better than their male counterparts in computational skills. Alkali and Usman (1993) and Iroegbu (1998) also found no significant gender difference among students who were exposed to practical activities. Udousoro (2003) stated that there is no significant difference in the academic achievement of male and female students in chemistry. Babajide (2010) and Johnson (1991) who found that there was no significant gender difference among students who were exposed to practical activities at a senior secondary school level. Ahiakwo (1988) concluded that there was sex difference in performance with the chemistry process skill test. In this study, he concluded that girls showed better achievement than boys and that the difference between their mean scores was significant beyond P< 0.001. A study conducted by Olufunke and Adebayo (2014) on the Effect of Gender on Basic Science Practical Skills of Lower Primary School Pupils. Results showed that there was no significant moderating effect of gender on pupils’ practical skills in Basic Science. The study concluded that practical skills should be constantly developed in males as
well as in female pupils so as to improve Basic Science practical skills of lower primary school pupils to get a better achievement in science.

A study conducted by Adesoji (2005) on Expressive Teaching Behavior: Bridging the Gender Gulf in Secondary School Chemistry Achievement. The results obtained in this study showed that students exposed to expressive teaching behavior performed significantly better than their counterparts exposed to conventional teaching behavior ($t = 6.35; p < 0.05$). It was concluded that students’ chemistry achievement depended on the extent to which the teachers made use of expressive teaching behavior. This could be due to the fact that the use of expressive teaching behavior fosters a conducive classroom environment and positive classroom interaction and participation. Inyang and Jegede (1991) reported that gender had no effect on students’ achievement in science.

Concluding that this section has conceptualized the problem of the study to the fact that gender could be one of the main causes of students’ performance in chemistry. Researchers such as Busolo (2010), Nwosu and Okeke (1995), Alexo Ponlou (1997), Okpala and Onocha (200) and Njoku (2002) found that there was gender difference in favor of boys in relation to practical skills and achievement in chemistry, while Shaibu and Mari (1997), Ogunkola & Bilesanmi-Awoderu (2000) found the gender difference in the favor of the female. On the other hand Raimi (2002), Akale and Usman (1993) and Iroegbu (1998), Udousoro (2003), Babajide (2010), Johnson (1991), Ahiaikwo (1988), Olufunke and Adebayo (2014) and Inyang and Jegede (1991) reported that gender had no effect on students’ achievement in chemistry.

2.6 Studies Related to Attitude towards Chemistry

Science education emphasizes on students’ attitude toward science, therefore, the research on the students’ attitudes towards chemistry has drawn a great attention by researchers for the past many years.

About the definition of attitude towards science Petty (1995) reached at the conclusion that all definitions for the attitude are within a consensus in which they are positive or negative thoughts, feelings or behaviors towards the objects around us. Therefore, different researchers’ defined attitude differently. According to Simpson and Oliver (1990) attitude is a concept that gives emotional trends relating to events or ideas. Therefore phrases “I like science” or “I
enjoy science courses" enumerate as attitude. According to Osborne et al. (2003) attitude consists of different sub-constructs which ultimately gives rise to a person’s attitude towards science.

One should not take the scientific attitude as attitude towards science. These are two different terminologies as Bennett (2003) makes a clear distinction between attitude towards science and scientific attitude. According to him, attitude towards science is linked to the views and images that the 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. Gardner (1975) mentioned two categories about the broad nature of attitude, i.e., attitude toward science that related to interest in science. Simply attitude towards science like or dislike of any things related to science. The second category is “scientific attitude” which is a scientific process (open mindedness, objectivity, honesty). In the words of Yara (2009) attitude towards science denotes interest or feeling towards studying science. It is the students’ disposition towards liking or disliking science. Gardner (1975) defines attitude as “a learned predisposition to evaluate in certain ways objects, people, actions, situations or propositions involved in learning science”. (p. 34)

Flowers (1987) defines attitude as a particular feeling about an object or thing and therefore involves a tendency to behave positively or negatively in situations that involve the object or thing. The researcher further asserts that attitudes are partially emotional and that they are acquired not innate. From the above definition, it reveals that an attitude is directed toward object and this may be an individual, school policy subject or even ideas or any material object.

Developing positive attitudes towards science is one of the key goals for teaching and learning sciences Malik et al. (2010) conducted a study on the Effect of Problem solving teaching strategy on 8th Grade students’ attitude towards Science. The study was conducted with 60 students 30 in each experimental and control group at a public high school in Islamabad the federal capital of Pakistan. A scale regarding attitude towards science learning (AtSL) with
Cronbach’s alpha 0.86 was administered to the students of both experimental and control groups. It was concluded that student in experimental group made a positive improvement in attitude towards science learning as compared to students in the control group. Slay (2008) worked on the effects of directive and non-directive problem-solving on attitudes and achievement of students in a developmental science course. It was concluded that attitude became more positive direct instruction. Miller (1961), Morse and Morse (1995) found that students with positive attitudes towards science had positive attitudes towards their science teacher, science curriculum and science-classroom climate. Students’ attitude toward science is more likely to influence the success in science courses.

In contrast to positive attitudes toward science, there are negative attitudes as well. These negative attitudes have been documented in numerous studies for a number of years in relation to courses in research, statistics and mathematics (Adams & Holcomb, 1986; Elmore & Vasu, 1980; Wise, 1985). According to Wise, (1985), Waters, Martelli, Zakrajsek, and Popovich, (1988) one of the main problems of these negative attitudes is that they have been found to serve as obstacles to learning. In turn, these negative attitudes have been found to be associated with poor performance in such courses (Elmore, & Lewis, 1991; Woelke, 1991; Zeidner, 1991). However, (Meece, Wigfield, & Eccles, 1990) suggest that attitudes are actually mediators between past performance and future achievement.

There is a mixed finding of different researches about activity based teaching and attitude toward science. Akporehwe and Onwioduoki (2003) conducted a study and found out that the activity-based approaches have significant effects on students’ attitudes with guided discovery approach being most facilitative. It was also shown that gender and the interaction between opposite gender and activity-based approaches were not significant. This gave an indication that other factors play great role in enhancing student’s attitudes. Similarly Townsend (2012) conducted a study to examine the impact/effect of activity based activities students' attitude toward science. The researcher reported that not only did student’s attitudes toward science improve, but confidence and understanding of science increased as well. Students had positive feelings toward science; even they did not choose it as their favorite subject. According to students' science was more enjoyable when activities and laboratories
were a part of learning experience. A similar study has been conducted by Demircioglu, Gokhan and Ayas. (2005) in Turkey to investigate the effect on the student achievement and misconception of new teaching material developed for the unit" acid and base". Also the student attitudes toward chemistry were explored. The results indicated students in the experimental group had higher attitude toward chemistry. This showed that the implementation of the new material produced better results both in term of achievement and attitude. According to Gnanadesikan et al, (1997) the use of activities has invigorated our teaching and improved our attitude. Some students are very positively to this, while others show negative response. Hatice (2012) conducted a study to investigate the effect of interaction between gender and grade level on secondary school students’ attitudes toward chemistry as a school subject. The sample is comprised of 197 students across Grades 9 to 11. The researcher had adopted Attitude Scale towards Chemistry, developed by Geban & Ertepinar (1994. Enjoyment of chemistry” and “importance of chemistry were the two principal component analyses. Overall, the findings of this study offer that the educational objective of developing positive attitudes toward chemistry lesson is not fully achieved in Turkey.

Another study was conducted by Townsend (2012) on the Effects of laboratory-based activities on student attitudes toward science. The sample comprised of 40 fifth grade students were taught science over a five month period on laboratory based activities. It was concluded that the using of labs/activities inspired and increased the understanding of science in fifth grade students which showed a positive attitude towards science.

Smist and Owen (1994) believe that chemistry attitudes are predicted positively by self-efficacy and through chemistry attitudes self-efficacy reduced indirectly chemistry laboratory anxiety. In other words, attitude towards chemistry served as a mediator in linking self-efficacy and chemistry laboratory anxiety. Student’s attitudes toward chemistry are very important for their involvement in learning in laboratory as well as in classrooms. Similarly Pajares and Schunk (2005) reached at conclusion that students’ self-efficacy beliefs play an integral role in their academic motivation, learning, and achievement. According to Bandura (1986) self-efficacy is one’s belief in his/her capacity to perform a specific task. Individuals may assess their skills and capabilities prior to performing certain actions or activities. Bandura (1986) further
added that if individuals have high self-efficacy to perform activities, they are more likely to attempt doing those activities and to develop positive attitudes toward them.


2.7 Gender Related Research on Attitude toward Science

Gender and attitude toward science have been the focus of scientific research for many years. Memon (2007) considers women's education very important because it provides an important means for their authorization. The development of the mind, training in logical and analytical thinking, organizational, administrative and management skills accrue through education. Enhanced self-esteem and improved financial and social status within the community is a direct outcome of education, especially science education. Education, therefore, be made available to all. For better parenting and healthier living also, education is an important factor. It is beyond doubt that educating girls can yield a higher rate of return than any other investment. This section will focus on gender difference in attitude toward science.

Gender is one of the important variables related towards pupils’ attitude to science. Therefore, studies have been conducted to find out gender wise attitude toward science. Some studies have reported the superior performance by male than female e.g. Ching (2010) in his study examined the effect of live simulation on students’ science learning and attitude. The researcher found in his study that male students had more positive adoption towards attitudes than females. He also found that the change in students’ science learning was significantly influenced by the teacher. According to Schbeci (1984), Beaker (1989) and Weinburgh (1995)
boys have a consistently more positive attitude toward science. The findings of their studies explained that owing to cultural socialization girls are given less hand on opportunity for the manipulation of scientific and technical devices. Bruce G. Waldrip (1994) in his study concluded that the overall student’s attitudes toward science were favorable, with boys having more attitudes than girls. For student attitudes the researcher has used (TOSRA). Test of Science Related Attitudes. (Francis & Greer, 1999; Jones, Howe, & Rua, 2000; O’Brien & Porter, 1994; Schibeci & Riley, 1986; Simpson & Oliver, 1985) all are of the opinion that boys have a great attitude toward science. Harvey and Stables (1986) conclude that boys have more positive attitudes to chemistry lessons than girls. On the other hand, Zubair, Nasir and Christine (2013) in their study on Attitude towards Science Learning found out that female students had a higher attitude towards science learning than male students.

In contrast, several studies have reported that there is no significant gender difference in attitude toward science. As Greenfield (1996) concluded that there were no gender differences in attitude towards science among students from grade 3 to 12 in four major ethnic groups of America. Similarly, Morrell and Lederman (1998) found no gender differences in attitudes among 5th, 7th and 10th grade students. Ahmad (2011) conducted a study to examine the relation between attitudes towards science in biology courses and students’ biology achievement. The researcher found no significant difference between girls and boys in attitude towards biology, (p<0.05), although the girls had better achievements in biology as compared with boys. The researcher concluded that among attitude towards science dimensions, only “biology is fun for me”, have meaningful and positive relation with students’ achievement in biology. Houtz (1995) found no significant difference in attitude among male and female students.

Concluding that Ching (2010), Schbeci (1984), Beaker (1989). Weinberg (1995), Waldrip (1994), Francis and Greer (1999), Jones, Howe and Rua, (2000) O’Brien & Porter (1994), Schibeci and Riley (1986), Simpson and Oliver (1985) are all of the opinions that boys have a great attitude toward science, while some of the studies reported that female students’ attitudes toward chemistry lessons are higher than male students Hofstein et al. (1977), Dhindsa and Chung (1999). In contrast, several studies have reported that there is no significant gender

2.8 Tools for Measuring Attitude toward Science

The following sections draw on a range of attitude studies to discuss issues of how attitudes toward science are measured, what attitudes are found and what factors influence attitudes toward science.

The most popular test which has been used the world over since its development by Fraser (1978) is Test of Science-Related Attitudes (TOSRA) which is designed to measure seven distinct sciences-related attitudes among secondary school students. There are 70 items to evaluate the attitude of science students toward science. TOSRA has been shown to be highly reliable. The seven scales are, Normality of Scientists, Attitude to Scientific Inquiry, Adoption of Scientific Attitudes, Enjoyment of Science Lessons, Leisure Interest in Science, and Career Interest in Science. These scales are called Social Implications of Science. These scales have the quality of group administration and all can be administered within the duration of a normal class lesson.

Regarding the format of TOSRA items involve a response format, first described by Likert (1932), which requires students to express their degree of agreement with each statement on a five-point scale consisting of the responses Strongly agree (SA), Agree (A), Not sure (N), Disagree (D) and Strongly disagree (SD). Scoring involves allotting 5, 4, 3, 2, I for the responses SA, A, NS, D, SD, respectively.

Since its development, TOSRA has been used in wide range the world over by researchers, such as, Smist (1996), Joyce and Farenga (1996), Adolphe (2002), Wolf and Fraser (2008), Eccles (2007), Fraser, Aldridge, and Adolphe (2010) used TOSRA for the measurement of attitude toward science of the secondary school students.

The demand of finding out attitude towards science increased day by day and researchers modified this instrument for other specific science subjects such as Biology, Physics and chemistry for research purposes like Wong and Fraser (1996) modified TOSRA into Questionnaire on Chemistry-Related Attitudes (QOCRA). This modified version was used to
examine student attitude towards chemistry. 1592 students were taken as a sample of 28 public schools. For another study Quek, Wong, and Fraser (2005) used the modified instrument QOCRA determination of student chemistry-related attitudes. This instrument was also an adopted version of TOSRA.

Similarly, Demircioglu (2014) used TOSRA in the exploratory factor analysis study for the scale of high school students’ attitudes towards chemistry. The purpose of this study was to develop a Likert-type scale that could measure high school students’ attitudes toward chemistry. In order to develop this scale, it was benefiting from some studies in the literature and expert ideas. After adjustments based on expert recommendations, a scale which consists of 25 items was developed and applied to 200 high school students. In order to determine the construct validity, exploratory factor analysis was performed. In this way, a final scale consists of 20 items. The scale’ reliability coefficient (Cronbach’ alpha) was found as 0.89

TOSRA is utilized in many countries, which is translated into their own language, such as in Pakistan, Rana (2002) translated the original version of TOSRA into Urdu language (Pakistan National language) to measure higher secondary school students” attitudes toward science and administered on 2,144 students of Punjab province in Pakistan. The reliability coefficient for TOSRA in this study was 0.9104. But Rana (2002) used 60 items in his adopted version instead of 70 of TOSRA.

Similarly, Adamski, Peiro, and Fraser (2005) modified TOSRA into Spanish Version to measure Spanish students” attitude towards science. The data were collected from 223 Spanish students of grades 4 through 6.

Another test of attitude toward science (STAQ) Simon-Troost Attitude scale Questionnaire was developed by Simon-Troost (1982) as a part of large scale longitudinal study of a relationship between effective variable and student achievement. This scale contains 15 subscale related to attitude toward science motivation to achieve in science, science anxiety, attitude toward science teachers and attitude toward science curriculum. The validation of instrument went through multi-stage and multi-years with thousands of students. The content validity was established through expert panel review, construct validity was established through item analysis and exploratory factor analysis. Internal consistency reliability for the
subscale was claimed to be above 0.90. Studies using STAQ reported Cronbach alpha coefficient for different subscale ranging from 0.33 – 0.95 (Owen et al 2008).

The Attitude toward science in school Assessment (ATSSA) is another instrument developed by Germann (1988), is used in large scale the world over. ATSSA measures, secondary school attitude towards science. At the initial stage there were 34 items based on five factors. After piloting and expert opinion 14 items were selected for final instrument of ATSSA. The Cronbach alpha estimate from four studies were all greater than 0.93.

Attitude toward science Questionnaire (ASQ) was developed by Parkinson, Tannera and Stable (1998). There are 33 items based on a Likert scale to measure the secondary school students’ attitude toward science. Principal component analysis factors revealed that there were six factors, I, e, enjoyment, level of difficulty, importance, reading and writing, practical work in science. The overall Cronbach alpha coefficient for the final questionnaire was 0.92. It is worth mentioning here that, in order to provide additional validity, the researchers interviewed 72 students with high, average and low achievers of attitude toward science.

An attitude towards Science (ATS) scale was developed by (Francis & Greer, 1999) to assess the student’s attitude towards science and beliefs about science. The instrument was designed for 3 point Likert scale. According to Francis and Greer, the 20 items of the scale were culled from an original batch of 62 science-related questions. 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. The alpha coefficient of different scale ranges from 0.88-0.91.

Chemistry education in secondary school has multiple purposes, and one of them is to develop students’ positive attitudes toward chemistry as a subject in the school curriculum. Although a variety of instruments have been developed by researchers to measure student attitudes, they are plagued with problems such as lack of theoretical rationale and absence of empirical evidence to support multidimensionality of the attitude construct.

In conclusion, a large number of tools, e.g. Questionnaire on Chemistry-Related Attitudes (QOCRA), an attitude towards Science (ATS), Attitude toward science in school Assessment (ATSSA) have been developed for measuring attitude towards chemistry covering different
dimensions of attitude, i.e., cognitive, affective and behavioral components. The most popular test which has been used the world over since its development by Fraser (1978) is’ Test of Science-Related Attitudes (TOSRA). In most countries (TOSRA) has been used with different version and modification.

2.9 Summary of Review of Literature

This chapter presented a review of literature relevant to the objectives of the study. This chapter was divided into five sections. In the first section of this chapter a discussion of science education, its importance and different aspects of science education is given. The discussion summarized that several researchers have identified different aspects of science education e.g. Good et al, (1985), Bailin (2002), (Fathman, Quinn, & Kessler, 1992), Rennie (2001), George E (2000), Rennie (2001), George E (2000), Goodrum, Hackling and Rennie (2001), Bybee, 1997; Goodrum, et al., (2001) have attempted to discuss aspects of science education and consider science education as ‘the discipline devoted to discoveries’, “critical thinking,” “multicultural worldview of scientific phenomena”, respectively while Rennie (2001), George E (2000), have discussed scientifically literate persons. While the remaining of the above such as Goodrum, Hackling and Rennie (2001), Bybee, 1997; Goodrum, et al (2001), Rascoe et al., 1999) Ales (1993) have discussed the science education and science literacy and considered that the main purpose of science education is to improve ‘scientific literacy, which, in turn develops a civilized society.

Science education is, in the broader sense, the expected outcomes; establishing modern thinking and attitudes in the local population, providing technical training to future labor force, forming a scientific and technical basis for scientific productivity and technological innovation and through all these leading to economic development.

Furthermore, all education policies of Pakistan, as discussed in the first part of this chapter, have also focused on one point to increase the intellectual behavior of students and also recognized the importance of science education and training as the essential part of the socioeconomic development in the country and considered the science education at secondary stage indispensable for the skilled manpower and intelligent citizenship.
Science is an activity based approach which can be taught by activities in which students must be active participants. Thus, regarding activity based teaching there is no different opinion of researchers. Archibong (1992), Mishra and Yadav (2013), Faiza (2012), Mastropieri and Scruggs (1995), Edward (2001), Harfield, Davies and Kenley (2007) Marilyn and Higgins (1977) are all agree in some way or in other that activity based teaching is a learning process in which “student is actively involved in doing or in seeing something done.”

Having the view of the researchers such as Prince (2004), Harfield, Davies, Hede, Panko and Kenley (2007), Hussain, et al. (2011), Boud and Feletti (1999) and Churchill (2003) it is concluded that the young students like doing something rather than listening or observing. Activity-based approaches provide students with hands on experiences. Activity-based teaching is an approach to education focusing on the idea that students should be engaged through actions. And activity-based teaching has been accepted as a paradigm for science education.

Regarding low cost activity majority of the researchers such as Mishra and Yadav (2013) consider that activity based teaching is expensive and most schools cannot afford well equipped science laboratories Therefore; low cost apparatus should be used. Asha Shafiq, Yitbarek(2012), Ara (1998) and Hashmi (1996) stressed on the use of low cost material in laboratories and its use as significantly effective than traditional approach of teaching.

Low cost apparatus increase the capacity of the students to observe. Thus, there should be a gradual shift from importing expensive apparatus to a reliance on low cost apparatus designed and manufactures by utilizing locally available resources.

the creative person, the definitions were focused on the specific characteristics or traits of the creative person. Various theories have been put forward by many theorists. However, most theorists agree that the creative process involves a number of components, most commonly: imagination, originality, problem solving, fluency and the ability to produce an outcome of value and worth.

Many researchers have developed creativity tests such as Creative Product Inventory by Taylor (1975), Creative Product Semantic Scale by Bessemer and O'Quin, (1987), Urban & Jelle (1996) developed a Test of Creative Thinking Divergent Production. Similarly, Natural Science Creativity Test by Friedlander (1983), but the best known test of general creativity, perhaps, is the Torrance Test of Creative Thinking (TTCT).

The investigation of students' attitudes towards science has been a substantive feature of the work of the science education research community for the past many years. (Petty, 1995) Simpson and Oliver (1990), Osborne et al. (2003), Yara (2009), Townsend (2006), Adesoji (2008a) Flowers (1987), Osborne et al. (2003), have defined attitude toward science in some ways because of its multi faced structure. Bennett (2003) makes a clear distinction between attitude towards science and scientific attitude. Crawley and Black (1992), Gardner (1975) Koballa (1988), Oliver and Simpson (1988), Salta and Tzougraki, (2004) have discussed the different components of attitude towards science. Adams and Holcomb (1986), Elmore and Vasu, (1980), Wise (1985), Waters, Martelli, Zakrajsek, and Popovich, (1988) have discussed negative attitude towards science Many theories have been put forward for attitude. All theories have been organized into four categories, i.e., consistency theories, learning theories, social judgment theories and functional theories. Regarding the gender discrimination Ching (2010), Schbeci (1984), Beaker (1989), and Weinburgh (1995), Bruce G. Waldrip (1994), Francis and Greer (1999) Jones, Howe and Rua (2000), O’Brien and Porter (1994), Schibeci and Riley (1986), Simpson and Oliver (1985) are all of the opinion that boys have a great attitude toward science. While some of the studies reported that female students' attitudes toward chemistry lessons are higher than male students (Hofstein et al., 1977; Dhindsa & Chung, 1999). In contrast, several studies have reported that there is no significant gender difference in attitude

The literature reveals that considerable work has been done on creativity, attitude toward science and achievement of the students separately. Most of the researchers have targeted primary, middle and elementary students. Very little work has been done on secondary level. Therefore, further study at higher levels may well contribute to the literature.

CHAPTER 3

METHODS AND PROCEDURE
This chapter describes a research paradigm, methodology, which have been adopted for this research work. According to Yang (2012) methodology is the congregation of methods and deals with the philosophical assumptions undertaken within the research process, while a method is a specific technique for data collection underlying those philosophical assumptions. This chapter details the research methods used in the present study under their headings;

3.1 Research Paradigm

A research paradigm refers to extensive belief system, a world view or framework that keeps the researcher on the right track to generate the objective knowledge. The nature of this particular research was in the post positivist paradigm and the use of mixed methods research to generate objective knowledge. The knowledge obtained from post positive verification through observation and reason in understanding behavior.

The researcher believes that reality cannot be measured exactly and that there are multiple realities within the world in contrast to positivist approach, which begins with the belief of existence of a single reality. (Lincoln & Guba, 1985; Strauss & Corbin, 1990)

Post positivist approach lays emphasis on objective and reliable knowledge on the basis of data and hence standards of validity and reliability are important for the tools used in data generation. With this belief system, the purpose of this research was to find universals with objective data to test the already existing theories and thus help in guiding the practices of teaching (Willis, 2000).

Post positivists accept that theories, background, knowledge and values of the researcher can influence what is observed. They believe that human knowledge is based not on unchallengeable, rocked-solid foundation but rather upon human conjunctures. These conjectures and beliefs are governed by warrants often grounded in reality and are subject to modification and withdrawal under further investigations. Current research aimed to investigate the impact of teaching low cost material on students’ creativity of grade 12 science students and then to find out achievement and their attitude toward chemistry keeping gender as background variable. The detail of research paradigm is given in the table; 3.1

Table; 3.1Summary of the Research Paradigm
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Post Positivist View</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Knowledge and values of the researcher can influence what is observed.</td>
</tr>
<tr>
<td></td>
<td>Truth is constructed through a dialogue</td>
</tr>
<tr>
<td>Beliefs</td>
<td>Multiple realities existed</td>
</tr>
<tr>
<td></td>
<td>Human knowledge is based on human conjunctures</td>
</tr>
<tr>
<td>Research Methods</td>
<td>Creativity test, Likert scale, Achievement test and structured interview used in the study</td>
</tr>
<tr>
<td>What Study data is based upon?</td>
<td>Measurable outcomes from questionnaire data and tests along with interview data</td>
</tr>
<tr>
<td>Study Sample</td>
<td>Clear and precise inclusion and exclusion of participants</td>
</tr>
<tr>
<td>Ethical issues</td>
<td>Informed consent, Confidentiality</td>
</tr>
<tr>
<td>Validity &amp; Reliability</td>
<td>Triangulation, Adequate sample size</td>
</tr>
</tbody>
</table>

### 3.2 Research Strategies

Mixed methods research strategy was adopted in this study, which is broadly defined by Creswell (2009) as “a research design is a procedure for collecting, analyzing, and “mixing” both quantitative and qualitative research and methods in a single study to understand a research problem.” (p. 14). Similarly, Tashakkori and Creswell (2007) defined mixed methods as “Research in which the investigator collects and analyzes data, integrates the findings, and draws inferences using both qualitative and quantitative approaches and methods in a single study or a program of inquiry” (p. 4).

The trend of research has been shifted to mixed method the world over for its new approach. According to Zaman (2011) in today's world the use of combined qualitative and quantitative research methods is a powerful trend in research method, because it gives a clear picture of situation under study.
Mixed method approach allowed ‘triangulation of data’ a term borrowed from navigation and military strategy, to argue for the combination of methodologies in the study of the same phenomenon (James, 2008) and was termed fundamental by Fraser & Tobin (1991) in obtaining validity in research.

Rossman and Wilson (1985) identified three reasons about quantitative and qualitative research; first, combinations are used to enable confirmation or justification of each other through triangulation. Second, combinations are used to enable or to develop analysis in order to provide richer data. Third, combinations are used to initiate new modes of thinking of attending to the paradoxes that emerge from the two data sources. Owing to its broad utilization mixed method design has been used by researchers (, Edwin, R. 2003 Bessoondyal, 2005; Ma’moon, 2005) in survey research along with qualitative data collection technique like interview and case study to get a better picture of the situation under study.

Triangulation is the key characteristics of mixed method research. The researcher used triangulation in this research. This type of research suits triangulation for many reasons. As Denzin, (1978) pointed out that three outcomes arise from triangulation i.e. inconsistency, convergence and contradiction. In contrast, Jick (1979) pointed out the following advantages of triangulation:

(a) Researchers become more confident of their results.
(b) It stimulates the development of creative ways of collecting data.
(c) It can lead to thicker, richer data.
(d) It can guide to the synthesis or integration of theories.
(e) It can uncover contradictions.
(f) By the virtue of its comprehensiveness, it may serve as the litmus test for competing theories.

In this particular study the impact of low cost teaching material on creativity, achievement and attitude towards chemistry at the secondary level was the main objective of the study. There was no prior creativity test available, especially in chemistry for grade 12 sciences. Therefore, creativity test was developed along with achievement test. Test of science related attitude (TOSRA) was modified for attitude towards chemistry. The use of triangulation
design was the second phase where both quantitative data, i.e. test scores from test of creativity, TOSRA for attitude towards chemistry and pre-test and post-test for achievement, and qualitative data, i.e. interviews from selected nine students and three teachers who taught the subject were collected simultaneously and both types of data was triangulated to address the research questions. The results from all types of instruments were analyzed using both quantitative and qualitative approaches and were triangulated to support and illustrate each other.

Different stages in the design of the study are illustrated in the diagram below

**Figure; 3.1 Stages of Research Studies**

![Diagram of Stages of Research Studies](image)

It consisted of three stages; in the first stage the researcher developed the instruments and in the second stage was the implementation of both qualitative and quantitative data was collected according to the objectives of the study. While in the last stage analysis of both types of data was made using respective approaches.

**3.3 Procedure of the Study**
In the first stage the creativity and attitude towards chemistry were explored in literature to list important aspects of these variables. The list was sent to experts for feedback. On the bases of feedback, instruments were developed.

The research instruments designed for the second stage of this study were;

a) Test of creativity for chemistry
b) Achievement Test in chemistry
c) Test of attitudes towards chemistry
d) Interview for students.
e) Interview for the teachers

3.3.1 Scale Development

After literature review the researcher collected many standardized psychological and educational tests for measuring these different variables. The following criteria given by Rosamma (2008) were adopted for selecting the tools. They are:

- The tool should be standardized for the population in question;
- The tools should yield valid and reliable measures of the variables in question;
- The tool should be in the regional language, which is the medium of instruction in most of the schools in the State;
- The tool should be a group test so that a reasonably large number of pupils can be tested at a time
- The tool should be provided with standardized instructions for administration and scoring.

Comprehensive data were collected through these instruments. The data were also used to compare the performance of students, gender wise. In order to get insight on the data, interviews were held with teachers and students as well. The objectives of the study, the required data and the selected tools are given in the table 3.2
Table 3.2 Objective of the study, the required data and selected tools

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Data</th>
<th>Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) To investigate the impact of low cost teaching materials on students’</td>
<td>Score</td>
<td>Creativity test for science (chemistry)</td>
</tr>
<tr>
<td>creativity.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2) To find out the impact of low cost teaching materials on student</td>
<td>Score</td>
<td>Pre-test and post test</td>
</tr>
<tr>
<td>achievement in chemistry.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(3) To assess the impact of low cost teaching materials on students’</td>
<td>Opinion</td>
<td>Likert scale</td>
</tr>
<tr>
<td>attitude towards chemistry.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(4) To identify the gender difference of the impact of low cost</td>
<td>Score</td>
<td>Creativity test for science (chemistry)</td>
</tr>
<tr>
<td>materials on their creativity.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) To find out the gender difference of the impact of low cost teaching</td>
<td>Score</td>
<td>Pre-test and post test</td>
</tr>
<tr>
<td>materials on their achievement in chemistry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(6) To find out the gender difference of the impact of low cost teaching</td>
<td>Opinion</td>
<td>Likert scale</td>
</tr>
<tr>
<td>materials on their attitude towards chemistry.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3.3.2 Population of the Study

All the science students of Government and private institutions of Khyber Pakhtunkhwa Pakistan studying in the 12th grade constituted population. According to Gay and Mills (2011)

“Population may be of any size and may cover almost any geographical area. Second, the entire group of interest to the researcher is rarely available. Thus a distinction is made between the population to which the researcher would ideally like to generalize study result, the target population and the population from which the researcher can realistically select subjects, which is known as accessible population or available population.”(P-124)
Target population includes all the science students of Khyber Pakhtunkhwa, studying at the 12th grade in public and private institutions. The total number of Government, Non Government Higher secondary schools and colleges is 1521; where 381166 science students (Class 11th to 12th) were enrolled. The detail of the target population is given in following table. 3.3. Only science stream students were included because these students are expected to do well in chemistry.

Table; 3.3; Number of Institutions of All Types in 2013-14 and Enrollment

<table>
<thead>
<tr>
<th>Institutions</th>
<th>Total No institutions</th>
<th>Enrollment ( Science students) Class 11th to 12th</th>
<th>Enrollment (Arts students) Class 11th to 12th</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys</td>
<td>Girls</td>
<td>Total</td>
</tr>
<tr>
<td>Government Higher Secondary Schools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>241</td>
<td>120</td>
<td>361</td>
</tr>
<tr>
<td>Mixed Government Higher Schools</td>
<td>Mixed</td>
<td>361</td>
<td></td>
</tr>
<tr>
<td>No of Non Government Higher schools / Colleges</td>
<td>472</td>
<td>189</td>
<td>661</td>
</tr>
<tr>
<td>No of Government colleges</td>
<td>103</td>
<td>45</td>
<td>148</td>
</tr>
<tr>
<td>Grand Total</td>
<td>826</td>
<td>344</td>
<td>1521</td>
</tr>
</tbody>
</table>

3.3.3 Sample and Sampling Procedure of Study

Nonrandom technique was adopted for selection of sample. According to Gay and Mills (2013) “in quantitative research a good sample is one that is representative of the population from which it was selected and selecting a population is not a haphazard process. Several techniques for selecting a sample are appropriate and selection depends on the situation because the researchers do not all provide the same level of assurance concerning representativeness. However, as with the population, the researchers sometime have to compromise the ideal for what is feasible” (p-125)
Therefore, the researcher tried his best to select the sample from the accessible or available population to keep the internal and external validity in minimizing the extraneous variables. All the 12th grade students enrolled in Oxford Education Academy Batkhela Khyber Pakhtunkhwa Pakistan were selected as a sample for the following reasons. This institution was accessible to researcher.

(1) The Principal and staff of the Institution were cooperative.

(2) This was a very populated institution and students from far flung area enrolled here.

(3) Both the genders were enrolled (Co-education)

The convenient sampling approach was adopted due to the nature of the study. This is a simple non random and non-probability technique where subjects are selected because of their convenient accessibility and proximity to the researcher.

The selected institution for research had both male and female professionally qualified staff. On average this staff has 10 years teaching experience. Most of the staff members belonged to the local area. The medium of instruction is English, but sometime teachers used local language. However the students used local language in their common conversation. Moreover, the students and staff of this institution belonged to the same race and communities.

Students from the school were selected as ultimate sample detailed below

(i) **Urban area:** 20 male students and 10 female students from male portion of this school.

(ii) **Rural area:** 20 male students and 10 female students from the female portion of this school were taken randomly as ultimate sample.

Proportionate approach in sampling was adopted as illustrated in the table given below.
Table 3.4; Composition of the Sample

<table>
<thead>
<tr>
<th>Groups</th>
<th>Total</th>
<th>Gender wise</th>
<th>Sector wise</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Experiment group</td>
<td>30</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Controlled group</td>
<td>30</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>60</td>
<td>40</td>
<td>20</td>
</tr>
</tbody>
</table>

3.3.4 Sub Sample

Purposive sampling technique was adopted for selection of students for interviews. The selection of the students was non-random. According to Bernard 2002, Lewis & Sheppard (2006), it is a nonrandom technique that does not need underlying theories or a set number of informants. Simply put, the researcher decides what needs to be known and sets out to find people who can and are willing to provide the information by virtue of knowledge or experience.

The researcher selected nine students (six male and three female) and three male teachers for interview with the expectation that important information could be obtained from subject involved. The purpose of this study was to get rich information. Therefore, professionally qualified teachers with ten years or more teaching experience were selected to get rich responses from them. These selected teachers were those who taught chemistry to grade 12 and had command over chemistry subject.

Three students each from high, average and low achiever groups were selected. All the students were selected from the experimental group. The selection was on the basis of achievement in their creativity test, pre-test and post-test and on the researcher observation Likert check list.

3.3.4.1. Demographic Characteristics of Participations

This study implicated 60 science students of grade 12 (40 males and 20 females) that resided in the upper belt of Khyber Pakhtunkhwa Pakistan. For demographic details of the
participants the researcher checked the school records to collect important information including gender, age, date of enrollment, the percentage marks in the previous examination, and race/ethnicity, language as well as socioeconomic status, disability status and marital status. For socioeconomic and marital status, demographic questions were used.

Those students were enrolled in grade 12 who had successfully passed their 11 grade examination. Total numbers of enrolled students were 287 in pre-medical and pre-engineering classes. The average score of participants was Grade A (70% - 79%).

Participants spoke openly in Pashto, a local language and Urdu the national language was used in interviews when the researcher encountered students’ having difficulty in expressing themselves in English.

For the selection of the percipients pretest of chemistry achievement was conducted. On the basis of this test grouping, i.e. control group and experimental, was formulated. Both groups had the same number of male and female participants of the same characteristics. The detail about demographic characteristics is given in the table; 3.5

**Table; 3.5 Summary of the Demographic Characteristics**

<table>
<thead>
<tr>
<th>SNo</th>
<th>Characteristics</th>
<th>Demographic information/ Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Date of enrollment</td>
<td>31st August 2015</td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>40 male and 20 female</td>
</tr>
<tr>
<td>3</td>
<td>Age</td>
<td>Average age; 17 years and 7months</td>
</tr>
<tr>
<td>4</td>
<td>%age marks of the partisans</td>
<td>Grade A (70% - 79%),</td>
</tr>
<tr>
<td>5</td>
<td>Language Spoken</td>
<td>Pashto, a local language and Urdu the national language, English for medium instruction</td>
</tr>
<tr>
<td>6</td>
<td>Race/ethnicity</td>
<td>Muslims. Tribe Yousufzai</td>
</tr>
<tr>
<td>7</td>
<td>Socioeconomic status</td>
<td>Middle class family</td>
</tr>
<tr>
<td>8</td>
<td>Marital status</td>
<td>Unmarried</td>
</tr>
<tr>
<td>9</td>
<td>Geographic Location</td>
<td>Upper belt of Khyber Pakhtokhwa</td>
</tr>
</tbody>
</table>
3.4 Development, Validity and Reliability of Creativity Test

To assess creativity of the students a test of creativity was developed that was comprised of five components, i.e. sensibility to problem, fluency, flexibility, originality and elaboration & redefinition based on the previous research done by Rosamma (2008) where the researcher used a different number of items for each component. The validity and reliability of this were 0.76391 and 0.83 respectively. The components in developed test for the present research consisted of factors, sub-factors and further these sub-factors were divided into tasks. Therefore, the total number of items in the test was 68. The detail of components, factors and tasks are given in following flow sheet diagram 3.2

Items for the test of creativity were developed by the researcher according to the content of class 12 textbook of chemistry. The collection of items was then sent to experts, i.e. teacher educator and practicing teachers for comments. Item analysis was performed after trial testing before finalizing the test for major study in the light of experts’ comments and trial testing. Further details can be found in discussions about pilot testing and validation of the tests in upcoming sections of this chapter

As this test was based on diverging thinking of Guilford’s Theory: Creativity as Divergent Thinking (1956) and Mednick’s Theory (1962) the test format was designed to check the reasoning and thinking power of the students and use of questions like observing the apparatus, show your response, why it is so?, find the scientific cause, Identify the apparatus and mention their use. This reply pattern helps the students to their thinking power.
3.4.1 Content Validity of the Creativity Test

Content validity is an essential characteristic of any instrument which pertains to the degree to which the instrument fully assesses or measures the construct of interest. It is defined as “content validity determines the extent to which a set of assessment tasks provide a relevant and representative sample of the domain of tasks about which interpretation of assessment results are made “In other words “ content validity refers to which a test measure the content, it claims to measure “. (Linn and Miller, 2008, P, 74) For example, a school test of ability should reflect what is actually taught in the classroom. In content validity the researcher is concerned with whether the items measure the full domain implied by their label.

To ensure the content validity of the tests the researcher himself developed tests for this purpose. The researcher is a master degree holder in chemistry with 23 years teaching experience in teaching of chemistry subject. For the opinion and comments the test was sent to
11 educational experts and 4 subject specialists in chemistry for comments. The researcher himself visited some of these experts to have a discussion with them. Based on comments from these experts, some questions were modified and then pilot tested.

3.5 Pilot study

A careful planning is required for good research strategy and a pilot, or feasibility study is a part of this strategy. A pilot study gives advance warning about any shortcoming of the instrument to be applied for. De Vaus (1993, p. 54) pointed out “Do not take risk, pilot test first.” According to the report of NC3Rs (2006) a pilot study is a small experiment designed to test logistics and gather information prior to a larger study, in order to improve the latter’s quality and efficiency. A pilot study can reveal deficiencies in the design of a proposed experiment or procedure and these can then be addressed before time and resources are expended on large scale studies. Similarly, Porta (2008) reports that a pilot study is a small scale test of the methods and procedures to be used on a larger scale. The fundamental purpose of conducting a pilot study is to examine the feasibility of an approach that is intended to be used ultimately in a larger scale study. Therefore, the instruments were piloted before applying for large scale study. The first pilot study was administered to 80 students of grade 12 in oriental college Checkdara Dir (L). The concerned subject specialist cooperated very well with the researcher. The responses of the students were sought on prepared instruments and answer sheet was marked very carefully. The researcher felt some problems and shortcomings which needed to be addressed before large scale study.

- It was observed that creativity test was lengthy and required high degree thinking. The test consisted of 29 items. Each item had subsided items. Therefore, it took more than 5.30 hours to complete. Such a long time was unbearable for grade 12 students. The students were fresh and enthusiastic at the beginning and then found tired and took no interest in the proceeding. Therefore, most students did not attempt many items.

The problem of the lengthiness of the scientific creativity test was solved by splitting the test into two parts. To maintain equal time balance items were included in each part without disturbing the sequence of the items. The first part consisted of three components such as
Sensitivity to the problem, Fluency, Flexibility, while part second consisted of two components, i.e. Originality and Elaboration & redefinition because each section had more subsections.

In the second pilot study the test was administered in two consecutive days, which were fulfilled by the students in an enthusiastic manner.

In the achievement test, the researcher felt some problems and shortcomings which needed to be addressed before large scale study.

- Some items belonging to the same branch were in clustered form. Therefore, no deep thinking was required on the part of the student to mark the correct option.
- Some items had ambiguous options.
- Some items had simple options and could not show achievement.

Example; 1 Item with ambiguous options

<table>
<thead>
<tr>
<th>Items</th>
<th>Old Items</th>
<th>New Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item No, 10</td>
<td>Formers use Calcium Carbide (CaC$_2$) for ripening of fruits, because-----</td>
<td>Which compound the farmers use for ripening the fruit?</td>
</tr>
<tr>
<td></td>
<td>(i) It ripens the fruits</td>
<td>(i) Calcium Carbide</td>
</tr>
<tr>
<td></td>
<td>(ii) Gives heat to the fruits</td>
<td>(ii) Butane</td>
</tr>
<tr>
<td></td>
<td>(iii) Absorbs heat from the fruits</td>
<td>(iii) Calcium Hydroxide</td>
</tr>
<tr>
<td></td>
<td>(iv) Produces acetylene gas</td>
<td>(iv) Ethylene</td>
</tr>
</tbody>
</table>
Example; 2 Simple options which could not show achievement

<table>
<thead>
<tr>
<th>S.No</th>
<th>Old Item</th>
<th>New item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item No; 2</td>
<td>The general formula of alkynes is---- (i)CₙH₂n₊₂  (ii) CₙH₂n-2  (iii) CₙH₂n (iv) CₙHₙ</td>
<td>Which one of the following hydrocarbons contains at least one triple bond? (i) Butane (ii) Ethylene (iii) Propane (iv) Acetylene</td>
</tr>
<tr>
<td>Item No; 9</td>
<td>Which of the following is metal (i) Sulphur (ii) Oxygen (iii) Chromium (iv) Hydrogen</td>
<td>Which of the following is non-metal (i) Sulphur (ii) Sodium (iii) Chromium (iv) Copper</td>
</tr>
</tbody>
</table>

The first problem was fixed by reshuffling the items. Hence deep thinking was required on the part of the students for the correct option. The ambiguous items were made clear (Example; 2) Simple options were modified (Example; 1)

Test for attitude towards Chemistry was also piloted in order to remove the ambiguities and shortcomings. The following shortcomings were found;

- Some items were given in different form and students could not understand their real meanings. Consequently, the researcher had to explain that items to individual student regularly.
- Some items were given in the same form in consecutive cells.
- The items given were in large number.

The statements of items were made clear and easy to read and understand and those items which were one after the other were reshuffled.

For this particular study the interview questions were validated through experts prior to implementation. The interview draft was prepared and sent to experts for an opinion. The questions were interpreted and comprehended, retrieved relevant information integrated and evaluated the information and selected a response category. Owing to a pilot study a comprehensive interview draft was prepared for actual research study.
3.5.1 Pilot Study and Threats to Experimental Validity

During the pilot study, the researcher identified internal and external validity could be controlled. On the basis of threats, the researcher selected an institution and sample where all the threats could be controlled. The most important internal threats were mortality, instrumentation, testing and Differential Selection of participants faced during the pilot study. Due to mortality, the reduction in the number of participants occurred over time as individuals dropped out for different reasons, ie, firstly, some participations were not interested in the control group because there was nothing new for them, ie, traditional method. From the experimental group participants dropped out because too much effort was required. Secondly, the dropped participants managed to infect their friends in the control group to quit. 20 out of 80 participants dropped out. The researcher, in major study, overcame the mortality of groups by obtaining demographic information about the participants before the start of the study. The instrumentation may threaten the validity in several different ways. A problem may occur if the researcher uses two different tests, one for pre-testing and one for post testing. As there was no difference between the pretest and post test and due to item difficulty and discrimination this threat was overcome. The low cost material apparatus that was used in the experiment were also properly tested. Another great threat was on the Differential Selection of participants. According to Gay (2011) this threat refers to the selection of subjects who have differences before the start of the study that at least partially account for differences found in a posttest. The threat that the groups are different before the study begins is more likely when a researcher is comparing already formed group. The researcher tried his best to overcome this threat by selecting groups that were similar as possible and administered a pretest to check initial equivalence.

Several major threats to external validity can limit generalization of experimental results to other population. Among these threats Multiple-Treatment Inference belongs directly to participants. This threat occurs when a participant participates in a study which has already participated. The researcher, in broad study, made sure not allow a participant who had already
participated because the institution where the research was conducted not far away from the
institution where pilot study was done.

3.5.2 Item Analysis

Item quality has a major impact on the reliability of those poor items tended to reduce
reliability while good items tend to increase reliability; therefore the item analysis is quite
useful in test item selection. Item analysis uses statistics and expert judgment to evaluate tests
based on the quality of individual items, item sets, and entire sets of items, as well as the
relationship of each item to other items. It “investigates the performance of items considered
individually either in relation to some external criterion or in relation to the remaining items on
the test” (Thompson & Levitov, 1985, p. 163).

Therefore, item analysis was done on the basis of data from a pilot study. Two major
statistics, item difficulty and discrimination are often dealt with this procedure. Item analysis of
the items was done by using SPSS version 17 for the test of creativity.

Table 3.6: Items Analysis of Test of Creativity;

<table>
<thead>
<tr>
<th>Items No;</th>
<th>Difficulty</th>
<th>Discrimination</th>
<th>Items No;</th>
<th>Difficulty</th>
<th>Discrimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.59</td>
<td>0.52</td>
<td>17</td>
<td>0.39</td>
<td>0.46</td>
</tr>
<tr>
<td>2</td>
<td>0.65</td>
<td>0.35</td>
<td>18</td>
<td>0.69</td>
<td>0.60</td>
</tr>
<tr>
<td>3</td>
<td>0.69</td>
<td>0.24</td>
<td>19</td>
<td>0.51</td>
<td>0.40</td>
</tr>
<tr>
<td>4</td>
<td>0.58</td>
<td>0.41</td>
<td>20</td>
<td>0.88</td>
<td>0.06</td>
</tr>
<tr>
<td>5</td>
<td>0.45</td>
<td>0.25</td>
<td>21</td>
<td>0.51</td>
<td>0.78</td>
</tr>
<tr>
<td>6</td>
<td>0.57</td>
<td>0.53</td>
<td>22</td>
<td>0.63</td>
<td>0.89</td>
</tr>
<tr>
<td>7</td>
<td>0.54</td>
<td>0.16</td>
<td>23</td>
<td>0.44</td>
<td>0.74</td>
</tr>
<tr>
<td>8</td>
<td>0.57</td>
<td>0.35</td>
<td>24</td>
<td>0.53</td>
<td>0.34</td>
</tr>
<tr>
<td>9</td>
<td>0.66</td>
<td>0.52</td>
<td>25</td>
<td>0.57</td>
<td>0.73</td>
</tr>
<tr>
<td>10</td>
<td>0.16</td>
<td>0.14</td>
<td>26</td>
<td>0.72</td>
<td>0.54</td>
</tr>
<tr>
<td>11</td>
<td>0.61</td>
<td>0.47</td>
<td>27</td>
<td>0.40</td>
<td>0.53</td>
</tr>
</tbody>
</table>
Test item adjustments may need to occur in order to make test items better. Items with low item discrimination scores should be reviewed and altered because they may not assess the knowledge that teachers design the question to assess the question could be worded ambiguously (Hong, Purzer, & Cardella, 2011). For the reviewing and interpretation of the discrimination values Ebel (cited in Courville, 2004) issued four guidelines for the interpretations of its values

1. If \( D \geq 0.40 \): no item revision necessary;
2. If \( 0.30 \leq D \leq 0.39 \): little to no item revision is needed;
3. If \( 0.20 \leq D \leq 0.29 \): item revision is necessary; and
4. If \( D \leq 0.19 \): either the item should be completely revised or eliminated.

The difficulty level of the items in the Table 3.4 shows that 20 out of 32 items were found to fall in the moderate level with item difficulty between 0.51 and 0.85. Items No.10 and 28 were rejected in both item analyses and was excluded from the item test because this item was most difficult, while items no, I, 20 were most easy. Item no; 12,16,17,23, 25, 27, 29 and 30 were modified. 8 items were under 0.40 and above 0.30 where no or little revision was needed. 3 items were below, 19, therefore these items were eliminated. Consequently, some items where there was room revised while the other was left unchanged. 4 more items in place of rejected items were included and retested. Subsequently, the total number of items was again 32 for the final test. The final test was again reviewed by the team of experts. (Appendix-B)

3.5.3 Construct Validity of Creativity Test

Gay, (2011) stated that “construct validity is the most important form of validity because it asks the fundamental validity question. What is this test really measuring? In other words,
construct validity reflects the degree to which a test measures untended hypothetical construct, (P, 157). Similarly Dimetra (2010) is of the opinion that construct validity with whether the measures of the dimension of the a contract actually reflects the construct itself, or, in other words, whether the operationalization (definition) of a concept is consistent with its measurable components.

For this particular study the creativity test for chemistry was examined. The components have been found to be correlated positively and significantly with one another. Each of the components correlates considerably with the Total Creativity Test scores, the coefficients vary from 0.624 to 0.820. The average correlation is 0.7173 the details are given in Table 3.7 below.

Table 3.7 Inter correlations among Fluency, Flexibility, Originality and Elaboration & Redefinition

<table>
<thead>
<tr>
<th></th>
<th>Fluency</th>
<th>Flexibility</th>
<th>Originality</th>
<th>Elaboration &amp; Redefinition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity to the problem Pearson Correlation</td>
<td>.624</td>
<td>.752</td>
<td>.687</td>
<td>.692</td>
</tr>
<tr>
<td>Fluency Pearson Correlation</td>
<td></td>
<td>.768</td>
<td>.616</td>
<td>.733</td>
</tr>
<tr>
<td>Flexibility Pearson Correlation</td>
<td></td>
<td></td>
<td>.724</td>
<td>.820</td>
</tr>
<tr>
<td>Originality Pearson Correlation</td>
<td></td>
<td></td>
<td></td>
<td>.757</td>
</tr>
</tbody>
</table>

Table 3.7 clears the justification of selection of Sensitivity to the problem, fluency, Flexibility, originality and Elaboration & Redefinition as the creativity test components for the study because all correlations are positive and significant.

3.5.4 Reliability of the Test of Creativity

According to Joppe (2000) reliability is the extent to which results are consistent over time and an accurate representation of the total population under study is referred to as...
reliability and if the results of a study can be reproduced under a similar methodology, then the research instrument is considered to be reliable. (p. 1).

Like validity, reliability of the test is also associated with the number of items provided that the new added item is not poorly constructed. “A reliable measure is one that provides consistent and stable indications of the characteristic being investigated.” (Anderson et al, 1976, P.325)

Without information about the reliability of the creativity indices we could not know how to interpret whatever finding we obtain concerning the interrelationship. (Wallah and Kogen 1965) As the medium of instruction was English at grade 12 science students the test was purely in English.

The reliability of the creativity test Chemistry was established using the test - retest method. The test-retest reliability coefficient was found to be 0.87. This value of obtained ‘r’ shows that the test is a reliable one.

From the validity and reliability of the creativity test, it is concluded that prepared tool is appropriate to measure creativity of grade 12 science students.

<table>
<thead>
<tr>
<th>S,No</th>
<th>FACTORS</th>
<th>RELIABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sensitivity to the problem</td>
<td>.78</td>
</tr>
<tr>
<td>2</td>
<td>Fluency</td>
<td>.76</td>
</tr>
<tr>
<td>3</td>
<td>Flexibility</td>
<td>.82</td>
</tr>
<tr>
<td>4</td>
<td>Originality</td>
<td>.74</td>
</tr>
<tr>
<td>5</td>
<td>Elaboration and Redefinition</td>
<td>.79</td>
</tr>
</tbody>
</table>

3.5.5 Development of Achievement Test

In higher secondary school chemistry book (Chemistry II), there are many activities which can be performed on low cost materials to promote the ability and thinking power of the students. Opportunity to learn chemistry through a process of activity seemed to have significant advantages. Students learn not only content knowledge but also develop scientific reasoning ability. Test of achievement was prepared according to the style of routine exam of
the schools / colleges. The objective of this particular study is to investigate the impact of teaching science through low cost materials on students’ achievement. Therefore, the researcher developed achievement test from the contents and activities of 12 grade chemistry. There were 29 items and every item had four options. These contents and activities were taught and performed with participants by the researcher respectively. The test was sent to 15 science teachers and lecturers in public and private institutions in their comments. And some necessary changes in questions and test as a whole were made for further testing. The test was also piloted to 30 students and item analysis was carried out. A summary of the item's statistics for objectives, type of item is given in table 3.5.4

**Example:** Each item consists of four options. You are directed to encircle the right option.

**Item:** which of the following produces more heat?

(i) Ethane (ii) Ethylene (iii) Acetylene (iv) All equally

**Item:** In Nelson cell brine is used. Brine means;

Solution of Salt (ii) Solution of Acid (iii) Solution of Base (iv) Solution of Sugar

**Table 3.8. Items Analysis of Test of Achievement:**

<table>
<thead>
<tr>
<th>Items No;</th>
<th>Difficulty</th>
<th>Discrimination</th>
<th>Items No;</th>
<th>Difficulty</th>
<th>Discrimination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.87</td>
<td>.06</td>
<td>16</td>
<td>0.43</td>
<td>0.39</td>
</tr>
<tr>
<td>2</td>
<td>0.83</td>
<td>0.31</td>
<td>17</td>
<td>0.70</td>
<td>0.61</td>
</tr>
<tr>
<td>3</td>
<td>0.70</td>
<td>0.47</td>
<td>18</td>
<td>0.52</td>
<td>0.46</td>
</tr>
<tr>
<td>4</td>
<td>0.73</td>
<td>0.31</td>
<td>19</td>
<td>0.73</td>
<td>0.47</td>
</tr>
<tr>
<td>5</td>
<td>0.83</td>
<td>0.47</td>
<td>20</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>6</td>
<td>0.83</td>
<td>0.23</td>
<td>21</td>
<td>0.80</td>
<td>0.41</td>
</tr>
<tr>
<td>7</td>
<td>0.77</td>
<td>0.43</td>
<td>22</td>
<td>0.43</td>
<td>0.40</td>
</tr>
<tr>
<td>8</td>
<td>0.73</td>
<td>0.39</td>
<td>23</td>
<td>0.70</td>
<td>0.42</td>
</tr>
<tr>
<td>9</td>
<td>0.87</td>
<td>0.06</td>
<td>24</td>
<td>0.80</td>
<td>0.55</td>
</tr>
<tr>
<td>10</td>
<td>0.73</td>
<td>0.31</td>
<td>25</td>
<td>0.77</td>
<td>0.61</td>
</tr>
<tr>
<td>11</td>
<td>.9</td>
<td>0.36</td>
<td>26</td>
<td>0.67</td>
<td>0.52</td>
</tr>
</tbody>
</table>
The difficulty level of the items in the Table 3.4 shows that 17 out of 29 items were found to fall in the moderate level with item difficulty between 0.51 and 0.85. Items No.1, 9, 14, 20 rejected in both item analyses and were excluded from the test item. Among these items, item no 14 and 20 were most difficult, while items no, 1, 9 were most easy. Item no; 2, 3, 5, 6, 21 and 27 were modified. 8 items were under 0.40 and above 0.30 where no or little revision was needed. 3 items were under 19; therefore, these items were completely rejected. So some item where there was room revised while the other was left unchanged. 4 more items in place of rejected items were included and retested. Subsequently, the total number of items was again 29 for the final test. The final test was again reviewed by the team of experts. (Appendix-B)

3.5.6 Development of test of Attitude towards Chemistry

Likert scale was constructed purely to measure the students’ attitude towards chemistry on the factors such as the Behavior tendency to learn chemistry (BTLC), Liking for chemistry laboratory work (LCLW), Liking for chemistry theory lesson (LCTL), Evaluation belief about chemistry (EBAC), Leisure interest in science (LIS) Enjoyment of chemistry (EC)

Example:

<table>
<thead>
<tr>
<th>S, No</th>
<th>Statement of Attitude towards chemistry</th>
<th>SD</th>
<th>D</th>
<th>NS</th>
<th>A</th>
<th>SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Activity based teaching method is the best way of learning chemistry.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>The use of low cost materials Teaching science increases motivation for science.</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
3.5.7 Construct Validity of test of Attitude towards Chemistry

For this particular study the test attitude towards chemistry was examined. The factors have been found to be correlated positively and significantly with one another. Each of the factor correlates considerably with the Total Test scores, the coefficients vary from 0.409 to 0.843. The average correlation is 0.666 the details are given in Table 3.6 below.

Table; 3.9 Inter correlations among the Factors of attitude test

<table>
<thead>
<tr>
<th>Liking for chemistry laboratory work</th>
<th>Liking for chemistry theory lesson</th>
<th>Leisure interest in science</th>
<th>Evaluation belief about chemistry</th>
<th>Enjoyment of chemistry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leisure interest in science</td>
<td></td>
<td></td>
<td>.409</td>
<td></td>
</tr>
<tr>
<td>Evaluation belief about chemistry</td>
<td></td>
<td></td>
<td>.680</td>
<td>.523</td>
</tr>
<tr>
<td>Liking for Chemistry theory lesson</td>
<td></td>
<td>.638</td>
<td>.606</td>
<td>.488</td>
</tr>
<tr>
<td>Liking for Chemistry theory lesson</td>
<td>.59</td>
<td>.843</td>
<td>.86</td>
<td>.805</td>
</tr>
<tr>
<td>Behavior tendency to learn Chemistry</td>
<td>.63</td>
<td>.80</td>
<td>.77</td>
<td>.73</td>
</tr>
</tbody>
</table>

The above table cleared the justification of selection on the factors such as Behavior tendency to learn chemistry, Liking for chemistry laboratory work, Liking for chemistry theory lesson, Evaluation belief about chemistry, Leisure interest in science, Enjoyment of chemistry, for the study because all correlations are positive and significant.

3.5.8 Reliability of Attitude towards Chemistry
The reliability of the creativity test Chemistry was established using the test-retest method. The test-retest took 25 days. The test-retest reliability coefficient was found to be 0.726. This value of obtained ‘r’ shows that the test is a reliable one.

Table 3.10 Items and the Reliability Coefficients of Final TOSRA Subscales

<table>
<thead>
<tr>
<th>S,No</th>
<th>FACTORS</th>
<th>RELIABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Behavior tendency to learn chemistry</td>
<td>.78</td>
</tr>
<tr>
<td>2</td>
<td>Liking for chemistry laboratory work</td>
<td>.76</td>
</tr>
<tr>
<td>3</td>
<td>Liking for chemistry theory lesson</td>
<td>.82</td>
</tr>
<tr>
<td>4</td>
<td>Evaluation belief about chemistry</td>
<td>.74</td>
</tr>
<tr>
<td>5</td>
<td>Leisure interest in science</td>
<td>.79</td>
</tr>
<tr>
<td>6</td>
<td>Enjoyment of chemistry</td>
<td>.87</td>
</tr>
</tbody>
</table>

\( N=35 \quad \text{Cronbach alpha} = 0.726 \)

Table 3.10 shows that reliability was revolving around the reliability measure of 0.86 by Shah, & Mehmood,(2011) for the whole test and no factor was found adversely affecting the reliability of the test therefore all items of factors were retained for large scale study.

3.6 Test Administration

For the implementation of the tools the researcher met the Head of the Institution and the teachers and discussed with them the purpose of the visit. Dates and time were fixed and the chemistry teachers allotted their periods for the administration of the tools. The researcher attended regularly the institution for delivering lectures to grade 12 chemistry classes on activity based approach to the experimental group and adopted lecture method to control group for 20 days. On the first day the researcher collected data through pre-test from both groups for grouping of the students, while the post test was used to collect the data at the last day to know the achievement of the students. The detail has been given in section 3.6.2 of Teaching Learning Process

Creativity test was divided into two parts. The first part “A” was consisted of Sensitivity to the problem, fluency, flexibility, whereas the second part, “B” comprised of Originality and
Elaboration and redefinition. The two parts of creativity tests were administered to the students on two different consecutive days. The timing of the test was decided to be flexible from 120 minutes to 180 minutes. The students were mentally ready for creating test as they were already told by the researcher on the first day briefing. But still before the start of the test of creativity the students were given a briefing about the purpose and nature of test items in order to get acquainted with the test and response pattern required for the study. During the entire testing process the researcher was present and three chemistry teachers assisted the researcher to ensure ease of the student and fairness in data collection as well. Both the groups were treated on the same day. Although the school administration has strictly advised the participants of both groups to attend the institution on the test conducting days, still three students were absent on the second day. These students had attended all the classes of the researcher during lecture. Therefore, the next day was reserved for these students.

On right next day TOSRA (Test of Science Related Attitude) for attitude towards chemistry was administered and was timed for 90 minutes. As it was not a routine test, therefore, students were not familiar with it in their school and college life, consequently the researcher guided them. However, the respondents’ response was quick and returned the test quickly. With this the first stage of data collection was completed and the next stage was to conduct the students’ interview.

Students’ interview was aimed generally to know students’ creativity, attitude towards chemistry and achievement and triangulate the findings with quantitative results to make a clearer understanding of the problems. There were nine questions overall in this interview; three questions were aimed to know students’ creativity. The other three questions were generated to know the students' attitude towards chemistry. The last three questions were organized to find out the achievement in chemistry of the students. The researcher himself conducted the interview to ensure ease of the students and fairness in data collection as well. The selection of the students was none-random. The selection of the students was on the basis of result of post-test of chemistry achievement test and creativity test. Nine students (6 male and 3 female) were interviewed, three from high achievers (2 male and 1 female), three from average (2 male and 1 female) and three from lower achievers (2 male and 1 female).
Interviews were audio taped after the permission of the students. All the male students recorded their interviews in voice recorder whereas the interviews of the female students were in written form because of the local condition.

All the students (the respondents) were observed in their regular activities such as in the classroom. All the observations were made over for 20 days. The proper tools for recording were kept handy. Various terms of the responders were studied.

Moreover, it was participant observation, therefore, the researcher as observer became a part of the situation being observed, in other words, the researcher participated in the situation while observing and collecting data on the activities. Rashid (1997) stated that observation deals with the overt behavior of persons in appropriate situations. And gained insights and developed a relationship with the participants. The whole procedure of test administration and data collection is given in the following study flow sheet diagram.

Figure; 3.3 Flow Sheet Diagram of Scheme of the Study
3.6.1 Selection of the topics

Having the objectives of the study, the researcher went through the chemistry book of grade 12 in order to select the topics to be taught in science classes. The topics were selected with the help of chemistry teachers who taught chemistry subject. Mostly the selected topics were those that could be taught through activities with low cost materials. For the instructional tools the researcher adopted advance lesson plans developed by Science Education Project – phase two (SEP-II) having five steps, Introduction, Presentation, different activities, recapitulation and evaluation. Each topic of this lesson plan was further divided into subunits to cover all the requirements of teaching and learning process and keeping in view the need of the students and the activities to be performed for each subunit. All the activities based on low cost materials were developed according to different competencies of each and every sub unit. For the development of such types of lesson plans the researcher himself was a member of this group.

The experimental group was taught through activities with low cost materials. For this purpose low cost material, equipment was fabricated. Such as Preparation of Acetylene Gas and its properties, Preparation of Sodium Hydroxide, Hydrogen and Chlorine Gas by Brine
solution in Nelson Cell, Electrolytic conduction of electricity, using various chemicals, available fruits and vegetables on low cost activity.

3.6.2 Teaching Learning Process

The class of experimental group started from 8:30 to 9:30 in the morning, followed immediately by class of control group from 9:40 to 10:40. The students followed this grouping only during these two hours at which one group had its chemistry class while the other group i.e. Control group was taking class of another subject on the same hour. This was followed by a crossover on the second hour. Both classes were handled by the researcher from February 5, 2015 till February 29, 2015 regularly.

The participants were engaged in activities. The whole class was divided into five appropriate groups. Each group was given apparatus fabricated with low cost materials. The researcher introduced apparatus with low cost material in the class and taught various topics of chemistry with the help of presenting apparatus and then asked the students to make modification to improve the apparatus. The participants interacted with materials to handle, manipulate and observe a scientific process. The learning environment was created where participants worked cooperatively and collaboratively, interacting in many ways including discussion. They discussed the various aspects of apparatus and tried to take notes during the teaching learning process.

The teachers helped the researchers in the whole process and controlled the internal and external threats. They also observed the active participation of the respondents during performing activities in the class.

The controlled group was taught through lecture method. It is a traditional method that deserves consideration as a teaching strategy in science instruction. When using this method, the researcher tried to justify it over other methods available for science instruction and coped with its limitations and used its strength to best advantage. During the lecture the participants took notes and asked questions.

3.7 Scoring of the Test

For scoring the tests the researcher used rubrics. A rubric is a multi-purpose scoring guide for assessing student products and performances. According to Mertler, (2001) rubrics
are rating scales that are used with performance assessments. They are formally defined as scoring guides, consisting of specific pre-established performance criteria, used in evaluating student work on performance assessments. There are two types of rubrics, holistic and analytic. According to Moskal (2000) and Nitko (2001) a holistic rubric requires the teacher to score the overall process or product as a whole, without judging the component parts separately. In contrast, with an analytic rubric, the teacher scores separately, individual parts of the product or performance first, and then sums the individual scores to obtain a total score. In this particular study for scoring creativity test analytical rubric was used. The scores vary from four to zero as given in Table 3.11, had been adopted for each component of creativity test. The score thus obtained for each component was summed up to get the total score for the test of creativity. The table given below described the category of responses which falls into different scoring scale from 1 to 4.

Excellent =4  Good =3 Fair =2 Unsatisfactory =1 Nil =0

**Table 3.11 Scoring Rubric for Creativity Test for Science**

<table>
<thead>
<tr>
<th>Creativity</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondent</td>
<td>Was extremely creative and presented with originality; used a unique approach that truly enhanced the project</td>
<td>Was creative at times; thoughtfully and uniquely presented</td>
<td>Added a few original touches to enhance the project but did not incorporate it throughout</td>
<td>Little creative energy used during this project; was bland, predictable, and lacked “zip”</td>
<td>No attempt to solve, completely incorrect</td>
</tr>
</tbody>
</table>

On the other hand creativity test for science was scored on percentage weight system dividing the scoring scheme into five categories. Table below gives a description of each category of scoring scheme

**Table 3.12 Percentage Scoring Rubric for Creativity Test for Science**
<table>
<thead>
<tr>
<th>Response score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full marks 100%</td>
<td>Extremely creative and presented with originality; used a unique approach that truly enhanced the project</td>
</tr>
<tr>
<td>75%</td>
<td>Creative at times; thoughtfully and uniquely presented</td>
</tr>
<tr>
<td>50%</td>
<td>Added a few original touches to enhance the project but did not incorporate it throughout</td>
</tr>
<tr>
<td>25%</td>
<td>Little creative energy used during this project; was bland, predictable, and lacked “zip</td>
</tr>
<tr>
<td>Zero</td>
<td>No attempt to solve, completely incorrect</td>
</tr>
</tbody>
</table>

### 3.8 Interviews

This particular study was a mixed method which emphasized the use of both qualitative and quantitative methods of data collection. The interview is aimed at getting information required by the investigator to test his hypothesis. The interview is in a sense, the foundation upon which all other elements rest. The interview method of collecting data requires the actual physical proximity of two or more persons and generally requires all the normal channels of communication be open to their use. Gholamreza (2010) stated that the in-depth interview is used to explore in detail the latent attitudes and feelings of the respondents.

The researcher in this particular study adopted structured interview, because nine questions were predetermined and conducted interviews with the students with the hope that more information will be collected about the students’ responses. Nine students were individually interviewed in the hope that this would provide opportunities for them to express their views with full confidence.

The main parts of the interview were consisted of asking questions and accurate recording of the responses of the respondents. The researcher listened carefully to them and asked supplementary questions whenever he needed to ask.

Keeping in the view six categories of interview bias by (Neuman 2014, P, 347) the researcher tried to reduce by adopting these six categories of interview bias.
• Errors by respondents; the researcher arranged individual interview in a quiet and safe place alone in order to avoid the respondents from forgetting, embarrassment and lying because of the presence of others.

• Unintentional errors or interviewer sloppiness; such type of interviewer bias is removed by the researcher by connecting the right respondent. The interviewer avoided from misreading a question, omitting a question, reading the question in the wrong order, recording the wrong answer to the question or misunderstanding the respondent.

• Intentional subversion by the interviewer; the interviewer did not make alteration of answer, omission or rewording of the questions, or choice of alternative respondents.

• Influence due to the interviewer’s expectations about respondents; the interviewer did not take influence about the respondents’ answer based on the respondents’ appearance.

• The interviewer was confident to probe properly. Because the pilot study has given the researcher full confidence.

• For the removal of the interview bias the influence on the answers due to interviewer’s appearance, tone, attitude, reaction to the answers and comments made in the interview schedule.

3.9 Access Provisions

The first ethical approval was sought from the principal of Sample College and appropriate permission was granted to the researcher after correspondence between the school principal and the researcher. To obtain the necessary approval, an outline of the research, including its ethics approval, proposed dates for its start and completion, its aims and benefits, methodology and details on how the results of the research would be disseminated, was provided. The request for entry was negotiated on the basis of:

• The researcher himself will teach the participants for 20 days the subject matter on low cost materials.

• The participant will get some revisions of selected topics which will help them for final examination.

• Being a teacher, the researcher was a part of the teacher community.
- For the professional and personal development of the researcher.
- The researcher maintained the liaison with teachers and school administration to ensure that adequate time was allowed for students to respond to the instruments.

Teachers and student participation in the research was voluntary and it was made clear that they could withdraw at any time. All the data collected in this particular research were kept confidential with different codes to conceal the identity of all participants.

3.10 Ethical Considerations

The researcher sought the informed consent of the students (participants), chemistry lecturers and the principal of the college by appropriate informal and formal means thus achieving a high level of cooperation and support in the research study. The researcher gave full consideration to all participants and their learning environments and found them mostly positive and interested in the research, keen to contribute their part.

The researcher - research participants’ relationship involved trust. The researcher maintained truthfulness in all communications. Students’ responses to the researcher were open and friendly.

Ethical consideration is significant in most experimental research because experimental treatment may involve people in contrived setting, asking them to engage in specific activities. Consequently, the researcher gave protection to the participants, which require that research participants not be harmed in any way, i.e., physically, mentally or socially. Participants openly expressed their views to the researcher. Those students who found difficulties in expressing their views in English used Pashto, a local language, as a whole and Urdu the national language on many occasions in interviews.

Fixed time of 20 days was taken from college administrations with the mutual consideration so that activities may not disturb the college routine work.

Research participants were assured of confidentiality. Confidentiality was maintained through the use of pseudonyms in reporting research findings. Moreover, any electronic data collected during the study were stored on a computer protected by passwords.
3.11 Data Analysis

Analysis of the data is the most important and crucial step in research. Once the data was collected, scored and tabulated, it has to be analyzed and interpreted to draw proper inferences. According to Mishra (2013) analysis of data means studying and organized materials in order to discover inherent facts. Without proper editing, systematic classification, tabulating and scientifically analyzing of data cannot serve any worthwhile purpose. Analysis of the data emphasizes the following main function;

- To make the raw data meaningful
- To test hypothesis
- To obtain significant results
- To estimate parameter
- To draw useful inference

Therefore, analysis carried out on the data gathered. References were made to the location of the table containing these data in Chapter 4. SPSS version 17 was used for statistical analysis.

Data gathered through tests analyzed using quantitative data analysis approach. Descriptive statistics, mean, standard deviation-test was used to find the mean difference across groups along with effect size to find the strength of the mean difference.

While analyzing qualitative data collected through interview, a qualitative approach of data analysis was used in this study. Researcher feels comfortable when makes comparison and contrasts between different categories of data analysis in qualitative research. It also requires that the researcher be open to possibilities and see contrary or alternative explanations for the findings. (Creswell, 1994)

The teachers’ interviews were analyzed qualitatively by tabulating important information from teachers in a table for comparison and contrast, while students’ interviews were analyzed using thematic analysis. Qualitative analysis, in contrast to quantitative analysis occurs concurrently with data collection.
The responses from interviews, that were recorded and fully transcribed, constituted the raw qualitative data for further analysis. These transcripts were then subjected to content analysis (Neuendorf, 2002) in which content was coded, tallied, ranked, and analyzed for emergent themes. More specifically, raw data were ‘chunked’ into color-coded categories.

As the interviews of the male students were tape recorded and that of females was in written form. The raw data in the form of the actual students’ interview were transcribed from videotaped and then description was made by the researcher in his own words keeping in mind the main themes. This was followed by the possible patterns and interpretation of the patterns from interviews.
CHAPTER 4

ANALYSIS OF DATA

This chapter provides analysis of data both quantitative and qualitative in relation to the objectives of the study.

In the first section, quantitative data collected through various valid and reliable tests, i.e., creativity test, TOSRA for attitude towards Chemistry and test for achievement were analyzed. Subsequently, gender difference in their creativity, achievement and attitude towards chemistry was analyzed by applying t-test for each of the dependent variables. Cohen’s D effect size was also calculated to find the strength of mean difference.

Second section of this chapter deals with analysis of qualitative data, collected through interviews, both from students and teachers and a check list was also interpreted. The interviews of both students and teachers were analyzed on thematic bases while the checklist on mean and standard deviation. Detail analysis and interpretation of data is stated below;

4. I Impact of Low Cost teaching material on Students’ Creativity

To know the impact of activity based teaching with low cost material on students’ creativity, the comparison groups, i.e. Experimental and control, were put to test of significant difference between means for large dependent groups. t test was applied separately for each of the dependent variables after treatment. To evaluate the amount of mean difference in each pair of mean scores effect size was calculated using Cohen’s d effect size. The statistical data used and the results of the tests of significance for the independent variables are given in Table 4. I.

| Table 4. I Comparison of Control and Experimental groups in their Creativity |
|---|---|---|---|---|---|
| Groups | Mean | Std. Deviation | T | Df | Sig(two tailed) | Cohen’s d Effect size |
Table 4.1, shows that there was significant difference between the creativity scores of the control and experimental group at 0.05 levels. Higher mean score of the experimental group (M=185.90) shows that experimental group did well in their creativity test. Higher standard deviation (SD= 47.050) of control group means that there was variation of score among students than the experimental group, while the lower standard deviation of experimental group indicates that students were focused on activities with low cost material. Moreover, to evaluate the amount of mean difference in each pair of mean scores effect size was calculated using Cohen’s D effect size. Cohen’s d value 0.926 > 0.8 shows that the effect size was found to be larger in the case of the experimental group.

**Table 4.2. Comparison of Control and Experimental groups in their Creativity**

<table>
<thead>
<tr>
<th>S.No</th>
<th>Variables</th>
<th>Groups</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t-value</th>
<th>Sig;</th>
<th>Cohen’s d Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sensitivity to the problem</td>
<td>Control</td>
<td>26.90</td>
<td>5.675</td>
<td>11.988</td>
<td>.000</td>
<td>0.998</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>33.62</td>
<td>7.636</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Fluency</td>
<td>Control</td>
<td>33.47</td>
<td>12.673</td>
<td>8.459</td>
<td>.000</td>
<td>0.841</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>42.13</td>
<td>9.547</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Flexibility</td>
<td>Control</td>
<td>4.59</td>
<td>1.768</td>
<td>6.963</td>
<td>.000</td>
<td>0.974</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>6.10</td>
<td>1.296</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Originality</td>
<td>Control</td>
<td>50.995</td>
<td>23.473</td>
<td>9.287</td>
<td>.000</td>
<td>0.995</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>73.97</td>
<td>22.672</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Elaboration and redefinition</td>
<td>Control</td>
<td>22.57</td>
<td>9.024</td>
<td>12.111</td>
<td>.000</td>
<td>0.941</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>29.43</td>
<td>5.104</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Significance Level  P < 0.05  Df=29
Table 4.2 indicates that there was significant difference between the students’ score in the test of creativity of the control and experimental group at 0.05 levels. Higher mean score of sensitivity to the problem (variable) of experimental group (M= 33.62) shows that sensitivity to the problem of the experimental group showed well in their Creativity test of science (extended to chemistry). Higher standard deviation of sensitivity to the problem of experimental group means that there was more variation of score among students than the control group indicating that some students were more impressed by the activities with low cost material than other fellows. Higher mean score of second variable, fluency i.e., of experimental group (M=42.13) shows that ‘fluency’ of experimental group showed well in their Creativity test of science (CTS). However, lesser standard deviation of ‘fluency of experimental group means that there was less variation of score among students than the control group .Which indicates that students were focused on activities with low cost material. Similarly, the mean scores 6.10, 73.97 and 29.43 of Flexibility, Originality and Elaboration and redefinition (variables) respectively of experimental group show that experimental group showed well in their creativity test, Conversely, lesser variations were found in the experimental group. Furthermore, to evaluate the mean difference further Cohen’s D effect size was used and its values were greater than Cohen’s d value of 0.8 (which represents large effect size comparing two means) showed large effect size in all aspects of creativity. Therefore, there was a great impact of low cost teaching materials on students’ creativity.

4.2. Impact of Low Cost Teaching Materials on Students’ Achievement.

Assessment of students’ achievement through low cost teaching material has been discussed by measuring their mean scores and standard deviation. To know the impact of teaching through low cost activities on students’ achievement t-test was applied after treatment. Cohen’s D effect size was also calculated to find the strength of mean difference .Table 4.5 below shows the details.

Table, 4.3 Comparison of Control and Experimental groups in the test of Achievement

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>T</th>
<th>Df</th>
<th>Sig(two tailed)</th>
<th>Effect size Cohen’s d</th>
</tr>
</thead>
</table>

Table 4.3 shows that there was significant difference between the achievement scores of the control and experimental group at 0.05 levels. Higher mean scores of the experimental group (22.7) shows that experimental group did well in their achievement test. Higher standard deviation of control group means that there was variation of score among students than the experimental group. Moreover, the Effect size 0.848 > 0.8 verifies the large size of groups.

On the basis of cognitive domain of Bloom’s Taxonomy of educational objectives, a pre-test and post-test were developed in the chapters of grade 12 of the Khyber Pakhtunkhwa Textbook of Chemistry. To know the impact of teaching science through activities with low cost materials on students’ achievement (Chemistry), t-test was applied after treatment. Table 4.6 below shows the details

<table>
<thead>
<tr>
<th>Cognitive Domain</th>
<th>Groups</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t-value</th>
<th>Df</th>
<th>Sig (two tailed)</th>
<th>Effect size Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Control</td>
<td>3.67</td>
<td>.959</td>
<td>20.943</td>
<td>29</td>
<td>.000</td>
<td>0.839</td>
</tr>
<tr>
<td></td>
<td>Experiment</td>
<td>4.13</td>
<td>.776</td>
<td>29.171</td>
<td>29</td>
<td>.000</td>
<td>0.848</td>
</tr>
<tr>
<td>Comprehension</td>
<td>Control</td>
<td>3.23</td>
<td>.935</td>
<td>18.936</td>
<td>29</td>
<td>.000</td>
<td>0.511</td>
</tr>
<tr>
<td></td>
<td>Experiment</td>
<td>3.63</td>
<td>1.033</td>
<td>19.258</td>
<td>29</td>
<td>.000</td>
<td>0.510</td>
</tr>
<tr>
<td>Application</td>
<td>Control</td>
<td>3.87</td>
<td>.730</td>
<td>29.000</td>
<td>29</td>
<td>.000</td>
<td>0.510</td>
</tr>
<tr>
<td></td>
<td>Experiment</td>
<td>4.23</td>
<td>.728</td>
<td>31.853</td>
<td>29</td>
<td>.000</td>
<td>0.510</td>
</tr>
<tr>
<td>Analysis</td>
<td>Control</td>
<td>3.67</td>
<td>.922</td>
<td>21.776</td>
<td>29</td>
<td>.000</td>
<td>0.397</td>
</tr>
<tr>
<td></td>
<td>Experiment</td>
<td>4.03</td>
<td>.890</td>
<td>24.824</td>
<td>29</td>
<td>.000</td>
<td>0.397</td>
</tr>
<tr>
<td>Synthesis</td>
<td>Control</td>
<td>3.13</td>
<td>.819</td>
<td>20.947</td>
<td>29</td>
<td>.000</td>
<td>0.639</td>
</tr>
<tr>
<td></td>
<td>Experiment</td>
<td>3.50</td>
<td>.682</td>
<td>28.097</td>
<td>29</td>
<td>.000</td>
<td>0.639</td>
</tr>
<tr>
<td>Evaluation</td>
<td>Control</td>
<td>3.57</td>
<td>.858</td>
<td>22.759</td>
<td>29</td>
<td>.000</td>
<td>0.09</td>
</tr>
<tr>
<td></td>
<td>Experiment</td>
<td>3.93</td>
<td>.828</td>
<td>26.029</td>
<td>29</td>
<td>.000</td>
<td>0.09</td>
</tr>
</tbody>
</table>
Table 4.4 shows that there was significant difference between the achievement scores of the control and experimental group at 0.05 levels on the base of cognitive domain. Higher mean scores of the cognitive domain of the experimental group (M=4.13, 3.63, 4.23, 4.03, 3.50, 3.93) shows that experimental group did well in their achievement test. Higher standard deviation (SD=.959, 0.730, 0.922, 0.819, 0.858) of control group means that there was variation of score among students than the experimental group. Moreover, to elaborate the difference further Cohen’s D effect size was also calculated and as the Table 4.6 shows a large effect size in case of Knowledge, Comprehension, Application and Synthesis, while medium effect size in Analysis and small size in the case of Evaluation. Therefore, there was a great impact of low cost teaching science materials on students’ achievement.

4.3; Impact of Low Cost teaching materials on students ‘attitude towards Chemistry

The modified form of TOSRA test was administered to treat both groups, i.e., control and experimental. The test was consist of six factors, i.e., the Behavior tendency to learn chemistry, Liking for chemistry laboratory work, Liking for chemistry theory lesson, Evaluation belief about chemistry, Leisure interest in science and enjoyment of chemistry. To know the impact of teaching science through activities with low cost materials on students’ attitude towards Chemistry, t-test was applied after treatment. The details are given in table 4.5

Table; 4.5 Comparison of Control and Experimental groups in attitude towards Chemistry

<table>
<thead>
<tr>
<th>Groups</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>t-value</th>
<th>Df</th>
<th>Sig (two tailed)</th>
<th>Effect size Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>121.20</td>
<td>8.235</td>
<td></td>
<td></td>
<td>.000</td>
<td>0.944</td>
</tr>
<tr>
<td>Experimental</td>
<td>132.03</td>
<td>13.975</td>
<td>8.616</td>
<td>29</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Significance Level  p < 0.05

Table 4.5 shows that there was significant difference between the attitude towards Chemistry scores of the control and experimental group at 0.05 levels. Higher mean score of experimental group (132.03) shows that experimental group showed well in their TOSRA test. Higher standard deviation of experimental group means that there was more variation of score
among students than the control group indicating that some students were more impressed by low cost activities than the other fellows. To evaluate the mean difference further Cohen’s D effect size was used and its values (0.944 > 0.8 Cohen effect size value) showed that a large effect size in case of experiment group.

Table 4.6 Comparison of Control and Experimental groups in attitude towards Chemistry (Factors)

<table>
<thead>
<tr>
<th>S.No</th>
<th>Factors</th>
<th>Groups</th>
<th>Mean</th>
<th>Std. Dev;</th>
<th>T</th>
<th>Sig ;</th>
<th>Effect size Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Behavior tendency to learn Chemistry</td>
<td>Control</td>
<td>27.93</td>
<td>2.741</td>
<td>7.938</td>
<td>.000</td>
<td>0.96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>31.01</td>
<td>3.998</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Liking for Chemistry theory lesson</td>
<td>Control</td>
<td>15.47</td>
<td>1.737</td>
<td>6.262</td>
<td>.000</td>
<td>0.76</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>17.50</td>
<td>3.246</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Evaluation belief about Chemistry</td>
<td>Control</td>
<td>24.90</td>
<td>2.568</td>
<td>9.055</td>
<td>.000</td>
<td>0.97</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>27.30</td>
<td>2.336</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Liking for Chemistry laboratory work</td>
<td>Control</td>
<td>21.53</td>
<td>2.909</td>
<td>7.289</td>
<td>.000</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>24.10</td>
<td>2.537</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Leisure interest in science</td>
<td>Control</td>
<td>16.73</td>
<td>3.352</td>
<td>8.137</td>
<td>.000</td>
<td>0.91</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>19.37</td>
<td>2.385</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Enjoyment of chemistry</td>
<td>Control</td>
<td>15.87</td>
<td>2.968</td>
<td>2.344</td>
<td>.000</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experimental</td>
<td>17.60</td>
<td>3.286</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.6 shows that there was significant difference between the students’ behavior tendency to learn chemistry, factor of attitude towards science, scores of the control and experimental
group at 0.05 levels. Higher mean score of experimental group (31.47) shows that the experimental group showed well in their behavior tendency to learn chemistry. Higher standard deviation of experimental group means that there was more variation of score among students than the control group indicating that some students were more impressed by low cost activities than the other fellows. Higher mean score of second factor, Liking for Chemistry laboratory work of experimental group (17.50) shows that experimental group showed well in their attitude towards science. Higher standard deviation of experimental group means that there was high variation of score among students than the control group, which indicates that students were more impressed by low cost activities than other fellows and liked to work in chemistry laboratory with low cost activities. Similarly, the mean scores (M=27.93, 15.47, 24.10, 19.37 and 17.60) of Liking for chemistry theory lesson, Evaluation belief about chemistry, Leisure interest in science and enjoyment of chemistry respectively of experimental group show that experimental group showed well in their TOSRA. The standard deviations of these factors were also higher in the experimental group showed that the students were impressed by low cost activities. To elaborate the difference further Cohen’s D effect size was also calculated and as the Table 4.6 shows a large effect size in factors of attitude towards chemistry was observed. Therefore there was a great impact of low cost teaching materials on students’ attitude towards science.

4.4. Gender Difference in the Impact of teaching Chemistry through Low Cost Materials on their Creativity.

Key to finding the gender difference with student creativity was important to this research. The gender difference with the creativity was determined using t-test. The values are given in table 4.7

<table>
<thead>
<tr>
<th>Female Groups</th>
<th>Groups</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>T</th>
<th>Df</th>
<th>Sig(two tailed)</th>
<th>Effect size Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>190.20</td>
<td>21.369</td>
<td></td>
<td></td>
<td></td>
<td>.000</td>
<td>0.85</td>
</tr>
<tr>
<td>Experimental</td>
<td>208.70</td>
<td>22.111</td>
<td>7.812</td>
<td>9</td>
<td></td>
<td>.000</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Significance Level P < 0.05
Table, 4.7 indicates that there was significant difference between the female students’ creativity scores of the control and experimental group at 0.05 levels. Higher mean score experimental group (208.70) shows that the female students of the experimental group showed well in their Creativity test of science (CTS). Higher standard deviation of experimental group means that there was more variation of score among female students than the control group indicating that students were more impressed by the activities with low cost material than other fellows. In addition, the Effect size 0.85 > 0.8 showed to be the larger size in case of experimental group.

Table; 4.8 Gender wise Comparison of Control and Experimental groups in Creativity

<table>
<thead>
<tr>
<th>Male Groups</th>
<th>Groups</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>T</th>
<th>Df</th>
<th>Sig(two tailed)</th>
<th>Effect Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>141.55</td>
<td>28.693</td>
<td>13.513</td>
<td>19</td>
<td>.000</td>
<td></td>
<td>0.98</td>
</tr>
<tr>
<td>Experimental</td>
<td>174.50</td>
<td>37.752</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Significance Level P < 0.05

Table, 4.8 Shows that there was significant difference between the male difference of the students’ creativity of science (extension to chemistry) scores of the control and experimental group at 0.05 levels. Higher mean score experimental group (174.50) shows that the male students of experimental group showed well in their Creativity test of science (CTS). Higher standard deviation of experimental group means that there was more variation of score among male students than the control group indicating that students were more impressed by the activities with low cost material than other fellows. Moreover, the Effect size 0.98 > 0.8 showed to be large in case experimental group.
Table 4.9 Gender wise Comparison of Control and Experimental groups in Creativity

<table>
<thead>
<tr>
<th>Groups</th>
<th>Male</th>
<th>Female</th>
<th>t-value</th>
<th>Sig</th>
<th>Effect size Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev;</td>
<td>Mean</td>
<td>Std. Dev;</td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>174.50</td>
<td>37.752</td>
<td>208.70</td>
<td>22.111</td>
<td>7.812</td>
</tr>
</tbody>
</table>

Significance Level  P < 0.05  Male  Df=19  Female  Df=9

The table 4.9 indicates that higher mean score of experimental group (208.70) shows that female in experimental group showed better than male in their creativity test with standard variation (22.111) lesser than the standard deviation of male which indicates that female students were focused on activities with low cost material. Furthermore, the effect size of experimental group is more than 0.5 which verifies the female had more creativity than female.

Table 4.10 Gender Differences Comparison of Control and Experimental groups in Creativity

<table>
<thead>
<tr>
<th>Scale / Variables</th>
<th>Groups</th>
<th>Male</th>
<th>Female</th>
<th>t-value</th>
<th>Sig</th>
<th>Effect size Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std Deviation</td>
<td>Mean</td>
<td>Std Deviation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity to the problem</td>
<td>Experimental</td>
<td>36.95</td>
<td>6.270</td>
<td>41.00</td>
<td>3.801</td>
<td>7.812</td>
</tr>
<tr>
<td>Fluency</td>
<td>Experimental</td>
<td>40.75</td>
<td>10.387</td>
<td>44.90</td>
<td>7.295</td>
<td>10.812</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Experimental</td>
<td>6.00</td>
<td>1.451</td>
<td>6.30</td>
<td>.949</td>
<td>10.812</td>
</tr>
<tr>
<td>Originality</td>
<td>Experimental</td>
<td>68.95</td>
<td>23.656</td>
<td>84.00</td>
<td>27.525</td>
<td>10.169</td>
</tr>
<tr>
<td>Elaboration and Redefinition</td>
<td>Experimental</td>
<td>27.90</td>
<td>5.261</td>
<td>24.00</td>
<td>3.136</td>
<td>13.858</td>
</tr>
</tbody>
</table>

Significance Level  P < 0.05  Male  Df=19  Female  Df=9

Table 4.10 shows that there was significant gender difference between the students’ creativity of scores of the experimental group at 0.05 levels. Higher mean score of sensitivity to the problem (variable) of female in the experimental group (41.00) shows that sensitivity to the
problem of female in the experimental group showed well in their Creativity test of science. However the higher standard deviation of sensitivity to the problem of experimental group shows that there was more variation of score among the male students than the female indicating that some male students were more impressed by the activities with low cost material than female. Higher mean score of fluency i.e., of female in experimental group (44.90) shows that ‘fluency’ of female in experimental group well in their Creativity test of science. However, lesser standard deviation of ‘fluency of female in experimental group means that there was less variation of score among female students than the male students, which indicates that female students were focused on activities with low cost material. Similarly, the mean score 6.30, 84.00 and of Flexibility and Originality (variables) respectively of female in experimental group show that female in experimental group showed well in their (CTS). Higher standard deviation of Flexibility and Originality of experimental group means that there was more variation of score among the female students than the male indicating that some female students were more impressed by the activities with low cost material than male. However, higher mean score of Elaboration & Redefinition (variable) of male in experimental group (27.90) shows that Elaboration & Redefinition of male in experimental group showed well in their Creativity test of chemistry. Higher standard deviation of Elaboration & Redefinition of experimental group means that there was more variation of score among the male students than female indicating that some male students were more impressed by the activities with low cost material than female. Therefore, there was a great impact of low cost teaching materials on students’ creativity, gender wise.

4.5 To find out the gender difference in the impact of low cost teaching materials on their achievement

To measure the gender differences of the impact of teaching chemistry through activities with low cost materials on their achievement in chemistry a t-test was applied to control and experimental groups. The obtained values are given in table 4.11
Table: 4.11 Gender Difference Comparison of Control and Experimental groups in Achievement test

<table>
<thead>
<tr>
<th>Groups</th>
<th>Male</th>
<th></th>
<th>Female</th>
<th></th>
<th>t- value</th>
<th>Sig(two tailed)</th>
<th>Effect size</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
<td>Std. Deviation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>10.50</td>
<td>6.030</td>
<td>19.90</td>
<td>2.86</td>
<td>21.5</td>
<td>.000</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>Significance Level</td>
<td>P &lt; 0.05</td>
<td>Male Df=19</td>
<td>Female Df=9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Entries in table 4.11 indicate that there was significant difference in the mean scores between the male and female achievement. The female performed significantly higher (M=19.90) than the male (10.50). Higher standard deviation of female in experimental group means that there was more variation of score among female students than the male indicating that female students were more impressed by the activities with low cost material than male in the experiment group. Similarly Cohen’s d value (0.3 < 0.47 < 0.5, medium) also justified the significance difference in experimental group of male and female.
Table 4.12: Gender Difference Comparison of Control and Experimental groups in Achievement test. (Cognitive Domain)

<table>
<thead>
<tr>
<th>Domain</th>
<th>Groups</th>
<th>Male Mean</th>
<th>Male Std. Dev</th>
<th>Female Mean</th>
<th>Female Std. Dev</th>
<th>t-value</th>
<th>Sig; Df=9</th>
<th>Effect size</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge</td>
<td>Experimental</td>
<td>4.05</td>
<td>.826</td>
<td>4.30</td>
<td>.675</td>
<td>20.146</td>
<td>0.00</td>
<td>0.173</td>
<td></td>
</tr>
<tr>
<td>Comprehension</td>
<td>Experimental</td>
<td>3.65</td>
<td>1.089</td>
<td>3.60</td>
<td>.966</td>
<td>20.93</td>
<td>0.00</td>
<td>0.048</td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>Experimental</td>
<td>4.15</td>
<td>.813</td>
<td>4.40</td>
<td>.516</td>
<td>22.83</td>
<td>.00</td>
<td>0.367</td>
<td></td>
</tr>
<tr>
<td>Analysis</td>
<td>Experimental</td>
<td>3.95</td>
<td>.945</td>
<td>4.20</td>
<td>.789</td>
<td>18.70</td>
<td>.00</td>
<td>0.287</td>
<td></td>
</tr>
<tr>
<td>Synthesis</td>
<td>Experimental</td>
<td>3.35</td>
<td>0.745</td>
<td>3.80</td>
<td>.422</td>
<td>28.500</td>
<td>.00</td>
<td>0.743</td>
<td></td>
</tr>
<tr>
<td>Evaluation</td>
<td>Experimental</td>
<td>3.75</td>
<td>0.851</td>
<td>4.30</td>
<td>0.675</td>
<td>20.146</td>
<td>.00</td>
<td>0.717</td>
<td></td>
</tr>
</tbody>
</table>

Significance Level: P < 0.05

Table 4.12 indicates the significant difference between the achievement scores of the male and female in experimental group at 0.05 levels. Female students mean score of Knowledge, Application, Analysis and Evaluation was 4.30, 4.40, 4.20 and 4.30 respectively of experimental group was better than that of male students in all cognitive aspects of achievement in Chemistry. However, male students mean score (M= 3.65, 3.80) of Comprehension and Synthesis respectively were better than female. The higher standard deviation (SD=0.826, 1.089, 0.813, 0.745, 0.745, 0.851) male in experimental group showed more variation of score among male students than the female indicating that male students were more impressed by the activities with low cost material than male in the experimental group. Furthermore, the Cohen’s d value gave different Effect size, i.e, 0.173, 0.048<0.2, small group for knowledge and comprehension, while 0.2<0.367, 0.287, showed medium effect size for application and analysis. Similarly 0.5< 0.743, 0.717 synthesis and evaluation respectively, showed large effect.
size. Therefore, there was a great impact of low cost teaching materials on students’ achievement" gender difference.

4.6 To find out the gender difference in the impact of low cost teaching materials on their attitude towards chemistry.

Mean scores of respondents on attitude scale and sub scales were calculated. t-test was used to see the significant differences among different categories of respondents like male and female.

Table: 4.13 Gender Differences Comparison of Control and Experimental groups in attitude towards Chemistry

<table>
<thead>
<tr>
<th>Groups</th>
<th>Male</th>
<th>Female</th>
<th>t-value</th>
<th>Df</th>
<th>Sig(two tailed)</th>
<th>Effect size Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>Std. Deviation</td>
<td>Mean</td>
<td>Std. Deviation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental</td>
<td>174.50</td>
<td>37.752</td>
<td>208.70</td>
<td>21.369</td>
<td>7.812</td>
<td>9</td>
</tr>
<tr>
<td>Significance Level</td>
<td>P &lt; 0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.13, reflects the significant gender differences, indicating that female (M=208.70, SD=21.369) had higher positive attitude towards chemistry than male (M = 174.50, SD = 37.752), however, greater standard deviation of the male shows that they were more impressed by the activities with low cost material than female. Furthermore the large effect size also verifies the female had more positive attitude towards chemistry.
Table 4.14 Gender Differences Comparison of Control and Experimental groups in attitude towards Chemistry

<table>
<thead>
<tr>
<th>Factors</th>
<th>Groups</th>
<th>Male</th>
<th>Female</th>
<th>t-value</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>Std.; Dev;</td>
<td>Mean</td>
<td>Std. Dev;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Behavior tendency to learn Chemistry</td>
<td>Experimental</td>
<td>31.25</td>
<td>4.65</td>
<td>31.90</td>
<td>2.33</td>
</tr>
<tr>
<td>Liking for Chemistry laboratory work</td>
<td>Experimental</td>
<td>17.80</td>
<td>3.25</td>
<td>16.90</td>
<td>3.35</td>
</tr>
<tr>
<td>Liking for Chemistry theory lesson</td>
<td>Experimental</td>
<td>17.80</td>
<td>3.25</td>
<td>20.80</td>
<td>3.15</td>
</tr>
<tr>
<td>Evaluation Belief about Chemistry</td>
<td>Experimental</td>
<td>23.40</td>
<td>2.60</td>
<td>24.50</td>
<td>2.41</td>
</tr>
<tr>
<td>Leisure interest in science</td>
<td>Experimental</td>
<td>19.40</td>
<td>2.72</td>
<td>19.30</td>
<td>1.63</td>
</tr>
<tr>
<td>Enjoyment of Chemistry</td>
<td>Experimental</td>
<td>17.50</td>
<td>3.61</td>
<td>17.65</td>
<td>2.67</td>
</tr>
<tr>
<td>Significance Level</td>
<td></td>
<td>P &lt; 0.05</td>
<td>Male Df=19</td>
<td>Female Df=9</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.14 shows male and female students’ mean scores in test of all aspects of attitude test were found out using t-test. Female students mean score was better than that of male students in all aspects of attitude towards Chemistry. Mean difference was significant in test of attitude towards chemistry for aspect which showed that female had positive attitude
towards chemistry and were more impressed by the activities with low cost materials. Therefore, there was a great impact of low cost teaching materials on students’ attitude towards Chemistry, gender difference.

4.7 Analysis of Qualitative data

This section gives an analysis of students and teacher interviews. The interviews provided the opportunity for the students to explore their further role played in their informal reasoning process. The great advantage of using an interview is that the students could seek more detail about the dilemmas presented if they did not fully understand the science concerned, thereby allowing students to demonstrate their reasoning patterns from an informed standpoint. Likewise, the interviewer was able to clarify any alternative views held by the students and also asked probing questions to elicit more detailed responses. The students’ interviews analysis was organized in a way to help in comparing among different strata of the sample and illustrated the quantitative data and thus made it easy for researcher to draw more useful interpretation and conclusion of the results. For collecting data from students one-on-one interviews were conducted.

Similarly, to get a greater insight three teachers were also interviewed. The main objective of the teachers’ interviews was to find the observation about the characteristics of students’ creativity, attitude towards chemistry and their achievement in chemistry. The important information from students and teachers had been presented in their respective information matrix and then conclusion was drawn on the basis of their responses.

4.8 Analysis of Students’ Interview

Students’ interview was conducted in order to know their confidence, understanding of the question, their solution strategies and make cross sectional comparison of the sample and triangulate the findings with quantitative results to make a clearer understanding of the problems. Nine questions were included along with side questions, the first three questions were aimed to know the students’ creativity, such as why did you use this material (pointing towards the material) in this particular experiment?. Four questions were about achievement in chemistry such as when dilute sulphuric acid (H₂SO₄) is electrolyzed using electrodes; the bulb gave light, what happens to the concentrated electrolyte? And two questions were about
attitude toward chemistry such as “How do you see teaching Chemistry? This information was useful in triangulation of their perception with the actual scores obtained through quantitative data. Nine students were individually interviewed. The selection of students was on the bases obtained scores in creativity test, achievement and test of attitude towards chemistry. The selection was;

Three from high achievers
Three from average achievers
Three from higher achievers

The researcher himself was interviewer and followed the interview etiquettes by listening more and talked less, avoiding interruption, keeping participants focused and asked for concrete detail, following up what participants said, prompted but always remain non judgmental, not debating with participants over their responses. Male interviews were audio taped after obtaining permission of the students, while due to orthodox condition of the area the female interview were in written form. The interview sessions lasted between 25 and 35 minutes for each individual and took three days to its completion. Owing to comprehensive interview nine questions were asked from each individual

As described in the above section nine students were interviewed. Important information from interview is presented in the following tables.
<table>
<thead>
<tr>
<th>Students</th>
<th>Justification for use of materials</th>
<th>Difficulty in understanding apparatus</th>
<th>Impact of electrolysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Used the balloon to control the volume of the gas.</td>
<td>No difficulty</td>
<td>Electrolyte dissociate into its ions. Concentrated electrolyte does not dissociate so no light is given</td>
</tr>
<tr>
<td>2</td>
<td>Used another empty plastic bottle to control the extra pressure of produced gas.</td>
<td>Not difficult, easy to understand</td>
<td>Con; H₂SO₄ gives no light</td>
</tr>
<tr>
<td>3</td>
<td>Used another empty plastic bottle as water reservoir to cover the water deficiency sued in experiment</td>
<td>Not difficult. But seen it for the first time.</td>
<td>The bulb is out of order. Therefore no light was given (Bad response)</td>
</tr>
<tr>
<td>4</td>
<td>Used thermo pores sheet for fixing electrodes in electrolyte cell.</td>
<td>Function is very easy but Its fabrication is very difficult</td>
<td>As Con; H₂SO₄ is strong electrolyte and cannot dissociate into its ions therefore, no light was given.</td>
</tr>
<tr>
<td>5</td>
<td>For dropping Calcium Carbide a small poly Athens bag fastened with string was used</td>
<td>Not difficult, saw for the first time.</td>
<td>No response</td>
</tr>
<tr>
<td>6</td>
<td>Used thermo pores for apparatus stand</td>
<td>Could not differentiate between cathode and anode compartments</td>
<td>Con; H₂SO₄ gives no light</td>
</tr>
<tr>
<td>7</td>
<td>Used extra small perforated plastic bottle for the addition of carbide pieces</td>
<td>Not difficult to understand</td>
<td>Without diluting H₂SO₄ cannot give light</td>
</tr>
<tr>
<td>8</td>
<td>Fixed a small drop pipe for the addition indicator</td>
<td>Enough to understand</td>
<td>No response</td>
</tr>
<tr>
<td>9</td>
<td>No addition for the</td>
<td></td>
<td>As Con; H₂SO₄ is strong</td>
</tr>
</tbody>
</table>
Improvement of apparatus | No difficulty | Electrolyte and cannot dissociate into its ions therefore, no light was given.

Table 4.16

<table>
<thead>
<tr>
<th>Students</th>
<th>The use of chemicals</th>
<th>Important teaching method</th>
<th>Perception about Teaching with low cost activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ca CO₃ and H₂S O₄</td>
<td>Activity based teaching; With this method every aspect of topic can be cleared very easily without any external pressure</td>
<td>Good and Participative approach</td>
</tr>
<tr>
<td>2</td>
<td>NaOH and NaCl.</td>
<td>Lecture plus Demonstration methods</td>
<td>Most interesting</td>
</tr>
<tr>
<td>3</td>
<td>Reaction of marble with concentrated H₂S O₄</td>
<td>Depend upon our teacher</td>
<td>I liked this method very much by giving me broad vision towards learning</td>
</tr>
<tr>
<td>4</td>
<td>No response</td>
<td>Activities based teaching; Useful strategies</td>
<td>Most interesting at this stage</td>
</tr>
<tr>
<td>5</td>
<td>Concentrated HNO₃ and Carbon (wrong response for such low cost activity)</td>
<td>Activity based teaching; facilitating learning</td>
<td>Activity which is performed with the local available materials develop our thinking power</td>
</tr>
<tr>
<td>6</td>
<td>Ca CO₃ and H₂S O₄</td>
<td>Teaching with low cost material because of Students centre and participative approach</td>
<td>Good approach</td>
</tr>
<tr>
<td>7</td>
<td>No response</td>
<td>Activities with low cost materials because the students learnt by themselves</td>
<td>Teacher should adopt this approach to every science subject.</td>
</tr>
<tr>
<td>8</td>
<td>Ca CO₃ and HCl (aq)</td>
<td>Activity based teaching; Students involved enthusiastically</td>
<td>Science subjects are always dry, this approach gave us new direction of learning</td>
</tr>
<tr>
<td>9</td>
<td>Carbon Dioxide and Oxygen</td>
<td>Activity based teaching; Keep students Involved in their learning.</td>
<td>Most interesting approach</td>
</tr>
<tr>
<td>Students</td>
<td>Effectiveness of low cost material</td>
<td>Perception about improvement</td>
<td>Creativity in apparatus</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------</td>
<td>-------------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>1</td>
<td>Yes. of course</td>
<td>Students gained more knowledge</td>
<td>Yes. Explained</td>
</tr>
<tr>
<td>2</td>
<td>Learnt more without any pressure</td>
<td>Gave specific and to the point thinking</td>
<td>Yes, demonstrated.</td>
</tr>
<tr>
<td>3</td>
<td>Why not,</td>
<td>Ability to learn more knowledge</td>
<td>Yes, showed</td>
</tr>
<tr>
<td>4</td>
<td>First, I did not know about the taught topic. But teaching with low cost materials I learnt many more aspects about topic</td>
<td>Teaching with low cost material able student to give new ideas and always take care of improvement</td>
<td>Making of indicator for acid base titration from vegetable</td>
</tr>
<tr>
<td>5</td>
<td>With this approach all text contents now cleared to me</td>
<td>Kept the students to work and learn positively</td>
<td>Made low cost apparatus for Boyls law.</td>
</tr>
<tr>
<td>6</td>
<td>Kept me to study</td>
<td>Students improved their studies</td>
<td>Model of atomic structure</td>
</tr>
<tr>
<td>7</td>
<td>Learnt practically,</td>
<td>Students worked in groups, discussed and shared ideas</td>
<td>No response</td>
</tr>
</tbody>
</table>
Regarding sensitive to the problem (apparatus test) most of the students were consistent and made some modification in the form of addition of some parts to the given apparatus with low cost material for the preparation acetylene gas for apparatus improvement that showed their creativity .Therefore the question of the researcher was as;

*Researcher; why did you use balloon in this particular experiment?*

*Nadia; I used the balloon on the top of the plastic bottle to control the pressure of the gas that might burst the plastic bottle, because huge volume of gas produced during activity*

The student had made justification for using balloon as an additional part to presented apparatus. Similarly, another student Maaz argued to control the produced gas in a huge amount by fixing another empty plastic bottle to the apparatus used for production acetylene gas. The presented and improved diagram is given below while the original picture of the improved apparatus of low cost material has been given in Appendix-E1

![Diagram of Presented and Improved Apparatus]
It was interesting to note that a female student gave a suggestion for dropping the pieces of Calcium Carbide (CaC$_2$), another small plastic bag suspended through a string in a plastic bottle where reaction took place must be added to apparatus.

![Diagram of experimental setup](image)

**Figure; 4.1; Low Cost Apparatus for the preparation of Acetylene Gas**

Another apparatus of Nelson cell with low cost material was presented for the preparation of Sodium Hydroxide, Chlorine and Hydrogen Gases. Some of the students gave suggestions for the improvement of this apparatus. In this regard the researcher asked a question as;

*Researcher;* why did you use extra inlet in this particular apparatus?

*Ajmal;* very simple sir, we can use the extra inlet of the addition of indicators for indication of Sodium Hydroxide that gives pink color in this solution which proves that Sodium Hydroxide is base in nature. Moreover,
we can also add brine solution in the case of its assumption and the flow of produced Chlorine and Hydrogen Gases will stop.

**Figure; 4.4 Low Cost Apparatus of Nelson Cell**

![Low Cost Nelson Cell Diagram](image)

This consistency of the students in form of modification in apparatus constructed by low cost material showed the students had creativity and generated new ideas. Activity based teaching promotes the creativity of the students by providing students them the opportunities to discover new things. They showed their attitude towards chemistry.

Regarding the difficult aspects to understand the work done in Nelson Cell.(constructed with low cost material), the students again had consistent views showing “No difficulty to understand”.

**Figure; 4.4 Original apparatus of Low Cost Material**

![Original Low Cost Material Image](image)
Consequently a great consensus was found among the students. Only one student was confused. As the students were taught by both the lecture and activity based methods, therefore, to know the students’ achievement the researcher asked the question as;

*Researcher; what did you find difficult to understand in the work you have done in Nelson Cell?*

*Urooj; No, it was not difficult. The work we done in Nelson cell were very easy. However, I must say that I saw and used this apparatus with low cost material for the first time.*

The response of the students shows clear understanding of the work done in Nelson Cell. Student had developed her conceptual understanding and made her to learn concepts meaningfully. The misconception and difficulties that had been developed in traditional lecture method removed. So the students felt no difficulty to understand the work done in Nelson cell.

Regarding the achievement of the students in chemistry the researcher prompted and asked question about achievement in chemistry and found bad or no response from two students. The % of correct response was 78. One of the comprehensive discussions between student and researcher was below.

*Researcher; when dilute sulphuric acid is electrolyzed using electrodes, the bulb gave light, what happens to the concentrated electrolyte?*

*Jawad; when dilute sulphuric acid is electrolyzed using electrodes and current was passing, because the dilute sulphuric acid contained water that dissociate the acid into its ions. While the concentrated acid had not water, Consequently, dissociation of ions not occurred.*

*Therefore current passed and no light given.*

The student was confident about his answer by saying that current could not pass through concentrated acid. His response shows his sound understanding and achievement in chemistry developed by activity with low cost material

The researcher had performed activity with low cost material using Lemon salt, Sodium Hydrogen Carbonate and four lighted candles of various sizes in length. After adding little water
to the mixture of lemon salt and Sodium Hydrogen Carbonate, due to the production of CO$_2$ the first lighted candle of small size went off and then others, therefore the asked question was as;

    Researcher; Tell me about one case when you tried to solve a problem of production of CO$_2$ with a totally different approach than is normally used.

    What was the result?

    Nadia; yes I can, for the production of CO$_2$ we can use Ca CO$_3$ and H$_2$S O$_4$ Furthermore, sir, this should be clear that CO$_2$ puts off the fire therefore, the first shortest candle went off then the second and so on.

The researcher found that 56 % of the students had inconsistent views. This fact was supported by the students’ interviews discussed in details in later section of this chapter.

To find the attitude towards science (extended to chemistry) the researcher asked the following question as

    Researcher; How do you see teaching Chemistry?

    Manzoor: the teaching of chemistry is an activity based approach, it should be taught by activity. This method makes chemistry an interesting subject. One can learn more and more without any external pressure. Moreover, it is a cooperative learning.

About the teaching of chemistry the students made a clear justification that activity based approach should be adopted. Only one student was found to be indecisive and responded that it depends upon teacher.

    Finding the answer of the previous question the researcher prompted and asked the students another question about teaching with low cost activity to find out attitude towards chemistry, a great consensus was found among the students, below was discussion between student and researcher.

    Researcher; what do you think by teaching low cost activity?

    Maze; low cost activity and practical work are the most important for teaching science. The students gain more knowledge about science. Low cost activity apparatus are easily available. These activities make science subject more
The student made justification and argued in the favor of activities with low cost materials and considered that the best and easiest approach towards science. Another student Mazhar considered this method as “Students centre and participative approach”

As regard learning more with low cost material, all students were consistent with remarks that they learnt more with this approach. Below was discussion between student and researcher.

*Researcher; do you think you learnt more with low cost materials in this class?*

*Usra; First I did not know about the taught topic. But teaching with low cost materials I learnt many more aspects about topic without any extra pressure.*

The conversation reveals that student had very strong belief and knowledge about activity with low cost material and considered it an important and useful way learning of chemistry in class.

As regard the improvement of the students with low cost materials in this class, the students had consensus among them that the whole class had improved themselves with this approach to produce new ideas. They worked in groups to share ideas freely. The question of the researcher and their discussion was as;

*Researcher; why do you think that students have made improvement with low cost materials in this class?*

*Azan; Yes, because students involved directly in learning process and helped used textbook effectively and all concepts were cleared.*

Student made clear justification about the improvement in the class by considering it the only way for learning chemistry more effectively. This showed their vision towards activity based approach.

An interesting discussion took place in the last session of interview when students were exploring and sharing the use of other activities with low cost material. Here the researcher saw a range of different views about low cost materials. To add students in providing an explanation, students were asked to describe how they would fabricate the activities with low cost material and convince their friends for fabrication (construction of low cost activities). As
the students were enthusiastic therefore, question of the researcher and their discussion was as;

*Researcher; Can you develop other apparatus with low cost materials? Please explain;*

*Ali; Yes, I can fabricate. Boil the water and fill half of glass with boiled water. Stir the boiling water for five to ten second and then empty it. Immediately place a peeled boiled egg on the mouth of the flask and observe it. The egg is sucked in the flask slowly and will respond into the flask. The reason is that the atmospheric pressure pushes the egg into the flask. Now invert the flask in a dish to take the egg out. Pour hot water on the bottom of the flask again slowly.*

The student had made great justification for using such type of low cost activity. Similarly, another student Shah Sani mentioned how indicator can be made from vegetable for acid base titration.

*Shah Sani; take vegetable such as green cabbage or any dark color vegetable you are provided easily and cut it in small pieces and boil it in a small volume of water in a glass beaker for five minutes, a considerable amount of vegetable coloring will come out. Now remove the pieces of vegetable from the beaker. Let the water cool down. Cut the lemon and began to squeeze it drop by drop over the beaker having color water. You will observe that the color will disappear. At this stage the addition of little amount of Sodium Carbonate the color again appears. By this low cost activity we can easily calculate acid base titration.*

Fabrications of low cost material by students’ shows that they were confident and impressed by activity based teaching with low cost material. This approach provided students with hands on experiences. Students talked about what they were learning and applied it to their daily lives.
4.8.1 Summary of Students’ Interview

Students expressed their conception about creativity and stated their preferences to experiment themselves rather than be told about a result. The conversation revealed that students had very strong belief and knowledge about activity with low cost material and considered it an important and useful way learning of chemistry in class. They made some modifications in the form of addition of some parts to the given apparatus. Students proved that they had the tendency to generate or recognize ideas, alternatives, or possibilities that may be useful in solving problems, communicating with others, and entertaining ourselves and others.

4.9 Analysis of Teachers’ Interview

To get a greater insight of data three chemistry teachers from the same institution were interviewed. The main objective of the teachers’ interviews was to find the conception about teaching through activities with low cost material and their observation about the characteristics of students’ creativity, achievement and attitude towards chemistry. The teachers were also asked to record their popular teaching strategies in context of creativity and also identify the most difficult and easiest aspects of creativity, achievement and attitude towards chemistry under study to triangulate their conception with the score of students in different aspects of creativity, achievement and attitude towards chemistry to find any inconsistencies. Furthermore, to find out the gender difference was also the objective of this particular study, therefore, the teacher observation about the comparison of students, gender-difference was also sought with possible reasons to give greater meaning to qualitative data and results obtained from t-test analysis.
4.9.1 Analysis of Teachers’ Interview

As described in the above section three teachers were interviewed from the same institution. Important information from the interview is presented in the following tables.

Table: 4.18 Interviews Summary of Teachers

<table>
<thead>
<tr>
<th>Teachers</th>
<th>Essence of creativity?</th>
<th>Aspects of creativity</th>
<th>Preferred teaching methods</th>
<th>Teaching strategies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mind in proper way</td>
<td>No response</td>
<td>Activity based teaching; gives great vision to the students</td>
<td>Mostly lecture method</td>
</tr>
<tr>
<td>2</td>
<td>Give some new ideas</td>
<td>Personality (Bad response )</td>
<td>Both lecture and demonstration method; Students improved their studies</td>
<td>Lecture method, giving notes</td>
</tr>
<tr>
<td>3</td>
<td>To think properly and deeply</td>
<td>No response</td>
<td>Demonstration; But don’t have enough time to demonstrate.</td>
<td>Lecture method, sometime demonstration</td>
</tr>
</tbody>
</table>
### Table 4.19 Interviews Summary of Teachers

<table>
<thead>
<tr>
<th>Teachers</th>
<th>Perception about improvement</th>
<th>Fabrication activity with low cost material?</th>
<th>Can your students fabricate activity with low cost material</th>
<th>gender wise comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Students involved directly in learning process and used the book effectively as well</td>
<td>Not before; Learnt some methods in this class</td>
<td>Yes. They are more creative</td>
<td>Female are better in my class. They are more sensitive and studious.</td>
</tr>
<tr>
<td>2</td>
<td>Effective teaching method, students learnt more</td>
<td>Cannot; but seen some apparatus</td>
<td>Yes, we have low cost material in our science Laboratory</td>
<td>Female; more studious and supportive</td>
</tr>
<tr>
<td>3</td>
<td>With teaching with low cost material student were able to give new ideas and asking new questions</td>
<td>Yes; explained</td>
<td>Some students can do</td>
<td>Female; in my class</td>
</tr>
</tbody>
</table>

All the teachers were able to respond, described creativity in the form of giving new ideas which are the original concept of creativity. About creativity and creative students they said.

*Teacher; “Students use their mind in order to generate or recognize ideas to the previous one. Due to which students develop their ability to understand”*

About creativity teachers’ knowledge was quite limited. They could not explained creativity in real worlds which showed their lack of confidence towards students’ creativity and just wanted to finish their courses of chemistry.
Regarding aspects of creativity teachers’ knowledge was quite limited. None of them responded positively. Regarding most important method for teaching science there was no opinion other than activity based teaching however, regarding teaching strategies they used lecture method and preferred to give notes to their students. The teacher gave arguments in the favor of lecture method as;

*Teacher;* ‘although to teach science we must adopt activity based teaching but lecture method is an efficient way to teach a large group of students. However, lecture demonstration saves more time, money and energy to present. Moreover, public and private colleges’ organizations do not arrange and support such type of teaching strategies and expected their teachers to finish their courses in time.*

From the above statement of teacher interview it is cleared that they were forced to adopt lecture method in colleges. One teacher how was not included in interview blamed both government and private colleges organizations for not providing any materials that could be used as a guild line for teaching of Chemistry. The teacher further added that during his entire service neither Government nor private organization have arranged refresher course in this regard for teaching of chemistry. According to teacher response training in the form refresher course must be given time and again once in a year in order to aware and share such experiences.

A considerable singularity was found in the direction of responses from teachers when asked about the improvement of the students with low cost materials in class. They all agreed that whole class had improved with this approach to produce new ideas. They worked in groups to share ideas freely and used their textbook effectively. One of the gave remarks as;

*Rashid;* with teaching with low cost material student were able to give new ideas and always take care of improvement in the form of asking new questions. Not only had we found these teaching strategies for students but ourselves as well. We want to arrange an exhibition for such type of material especially for chemistry teaching and learning. We know
that we can find a lot of material around us that can be used for this purpose.

Teacher showed their intention towards activities with low cost material and asked their heads of institutions to arrange such type of big exhibition, as it was suggested by Ara (1998), in his research study.

Regarding the fabrication of low cost activity, a poor response was found from the teachers none of them could fabricate low cost activity. Only one teacher could fabricate the low cost activity. When the researcher prompted and asked the question about fabrication of low cost activity the following discussion was proceeded.

Teacher; ‘yes I can produce a charge bubble. First prepare soap bubble liquid by mixing water, dish wash liquid and laundry starch. Pour water into a cup then add the dish liquid, laundry starch and mix well. Now try to make a big bubble. Make a special straw to charge up a bubble. Spread plastic on foil around the straw. Connect other straw to the previous one. Now make a bubble at the top of the straw and touch the negatively charged PVC pipe to the foil wrapped around the straw. Keep the bubble in the air by placing the PVC pipe. Bring a positively Perspex rod near the bubble. Consequently, we can observe the charge bubble’.

However teachers views towards students was different. They considered that their students could fabricate activity with low materials because there were a lot of apparatus with low material were laying chemistry laboratory.

There was a considerable singularity in the direction of responses from teachers when asked to compare different strata of the sample. The teachers’ response regarding gender difference favored female students. The common causes described by teachers were that female students were more sensitive, studious and supportive. In the favor of female one teacher said that the females were more motivated to undertake investigative activities and that would affect achievement.

To find out gender differences was a main objective of this particular study. A check list was maintained on daily bases having fifteen factors by the researcher himself and t-test were applied to analyze the observed data.(Appendix-g). Detail is given in table 4.17
Table 4.20 Gender Difference Comparison of Control and Experimental groups in Checklist

<table>
<thead>
<tr>
<th>Groups</th>
<th>Male</th>
<th>Female</th>
<th>t-value</th>
<th>Df</th>
<th>Sig(two tailed)</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>47.50</td>
<td>53.60</td>
<td>11.63</td>
<td>9</td>
<td>.000</td>
<td>0.48</td>
</tr>
<tr>
<td>Std. Dev; T Value</td>
<td>4.26</td>
<td>5.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43.55</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>38.10</td>
<td>41.55</td>
<td>40.86</td>
<td>9</td>
<td>.000</td>
<td>0.53</td>
</tr>
<tr>
<td>Std. Dev; T Value</td>
<td>4.38</td>
<td>4.54</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41.89</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Significance Level P < 0.05

Table 4.17 indicates that there was significant difference in the mean scores between the male and female. The female performed significantly higher (M=53.60) than the male (47.50). Higher standard deviation of female in experimental group means that there was more variation of score among female students than the male indicating that female students were more impressed by the activities with low cost material than male in the experimental group. To evaluate the amount of mean difference in each pair of mean scores effect size was calculated using Cohen’s D effect size. Cohen’s d value (0.3 < 0.48 < 0.5, medium) also justifies the significance difference in the experimental group of male and female. Similarly, in control group the female also dominated was found to be in control groups.

Table 4.21 Gender Difference Comparison of Control and Experimental groups in Checklist (Combined)

<table>
<thead>
<tr>
<th>Factors/ Aspects</th>
<th>Groups</th>
<th>Female</th>
<th>t-</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>Mean</td>
<td>Std. Dev</td>
<td>Mean</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------</td>
<td>------</td>
<td>----------</td>
<td>------</td>
</tr>
<tr>
<td>Keenness / Interest</td>
<td></td>
<td>2.55</td>
<td>0.510</td>
<td>3.80</td>
</tr>
<tr>
<td>Additional thinking</td>
<td></td>
<td>2.50</td>
<td>.513</td>
<td>3.10</td>
</tr>
<tr>
<td>Frequency of questions</td>
<td></td>
<td>2.55</td>
<td>.510</td>
<td>3.10</td>
</tr>
<tr>
<td>Asking o appropriate questions</td>
<td></td>
<td>3.85</td>
<td>.510</td>
<td>4.40</td>
</tr>
<tr>
<td>Notes taking</td>
<td></td>
<td>3.40</td>
<td>.503</td>
<td>3.80</td>
</tr>
<tr>
<td>Participation /discussion</td>
<td></td>
<td>3.60</td>
<td>.681</td>
<td>3.50</td>
</tr>
<tr>
<td>Motivation /eager to try new activities</td>
<td></td>
<td>2.47</td>
<td>.507</td>
<td>2.40</td>
</tr>
<tr>
<td>Organization of material/Activities</td>
<td></td>
<td>3.23</td>
<td>.858</td>
<td>3.30</td>
</tr>
<tr>
<td>Communication/express ideas clearly and Effectively</td>
<td></td>
<td>3.40</td>
<td>.814</td>
<td>3.70</td>
</tr>
<tr>
<td>Cooperation /work well with others</td>
<td></td>
<td>3.50</td>
<td>.513</td>
<td>3.20</td>
</tr>
<tr>
<td>Ability to work independently</td>
<td></td>
<td>3.45</td>
<td>.510</td>
<td>4.00</td>
</tr>
<tr>
<td>Following of direction carefully</td>
<td></td>
<td>3.20</td>
<td>.513</td>
<td>3.80</td>
</tr>
<tr>
<td>Give proper suggestions</td>
<td></td>
<td>3.20</td>
<td>.513</td>
<td>3.80</td>
</tr>
<tr>
<td>Assuming responsibility for own learning</td>
<td></td>
<td>3.50</td>
<td>.513</td>
<td>4.10</td>
</tr>
<tr>
<td>Response to teacher questions</td>
<td></td>
<td>3.30</td>
<td>.503</td>
<td>4.30</td>
</tr>
<tr>
<td><strong>Significance Level</strong></td>
<td><strong>P &lt; 0.05</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Male Df=19</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Female Df=9</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.18. indicates the significant difference between the observation scores of the male and female both in experimental group and control group at 0.05 levels. Female students mean scores (M= 3.80, 3.10, 3.10, 3.10, 3.80, 3.70, 3.30, 4.00, 3.80, 4.10, 4.30, 4.00) of Keenness / interest, Additional thinking, Frequency of questions, Asking of appropriate questions, Notes taking, Communication/express ideas clearly and Effectively, Organization of material/Activities, Ability to work independently, Following of direction carefully, Give proper suggestions, Assuming responsibility for own learning, Response to teacher questions respectively of experimental group were better than that of male students in all observed aspects. However, male students mean scores (M= 3.60, 2.47, 3.50) of Participation /discussion, Motivation/eager to try new activities, Cooperation/work well with others, respectively were better than female. The higher standard deviation of female in experimental group showed more variation of score among female students than the male indicating that female students were more impressed by the activities with low cost material than male in the experiment group. To evaluate the amount of mean difference in each pair of mean scores effect size was calculated using Cohen’s D effect size. Cohen’s d value shows that effect size was found to be small in case of Participation /discussion, Motivation/eager to try new activities, Organization of material/ Activities, while there was medium effect size in case of Keenness / interest, Communication/express ideas clearly and Effectively, Cooperation/work well with others. Similarly in control group the female students also dominated over male in all aspects of achievement test score except Notes taking (M=3.50) and Response to teacher questions (M=2.60) in which male dominated. Furthermore, Cohen’s d shows that effect size was found to be small in case of Asking of appropriate questions, Organization of material/ Activities, Communication/express ideas clearly and Effectively, Cooperation/work well with others, Assuming responsibility for own learning, there was medium effect size in case of Keenness / interest, Additional thinking, Frequency of questions, Notes taking, Ability to work independently, Following of direction carefully, Response to teacher questions.

Better performance for the female students showed that female had got much attention from
their teachers in institution and parents in home; therefore, they might work hard to fulfill the aspiration of their teachers and parents. Good academic performance by female students in science subjects had considerable effect on their future life. Due to orthodox and conservative situation of the area the parents do not like their daughters to adapt job except medical line which is considered the best job for them. Furthermore, female students tend to prefer the life sciences because they are always interested in human and animals. Therefore, in institutions at grade 12 level females are always attentive and get greater attention from their teachers for their devotion to study and trend of competition among themselves.

In conclusion, females tended to perceive most aspects of their science learning environment more favorably than their male counterparts. Both the researcher and concern teachers observed that, in general, female students were more excited by teaching through activities with low cost material than male students.
**CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS**

### 5.0 Chapter Outline

In this chapter, a brief outline on how the research questions in the study were answered is presented. The data collected during the study provide the basis for the conclusions, recommendations and discussion on the limitations of the study.

### 5.1 Overview of the Research

This study investigated the impact of low cost teaching material on creativity, achievement and attitude towards science at secondary level at Khyber Pakhtunkhwa. There are six objectives of this research: firstly, to investigate the impact of low cost teaching materials on students’ creativity; secondly, to find out the impact of low cost teaching materials on students’ achievement in science; thirdly to assess the impact of low cost teaching materials on students ‘attitude towards science; fourthly, to identify the gender difference of the impact of low cost materials on their creativity; fifthly, to find out the gender difference of the impact of low cost materials on their achievement and finally, to find out the gender difference of the impact of low cost teaching materials on their attitude towards science.

These six objectives correspond to the research questions of the study, which draw together the research methods, data collection, and data analysis throughout this study. The six research questions which guided this quantitative and qualitative data analysis were:

1. What is the impact of low cost teaching materials on students’ creativity?
2. What is the impact of teaching low cost materials on students’ achievement in Chemistry?
3. What is the impact of teaching low cost materials on students ‘attitude towards chemistry?
4. What is gender difference in the impact of low cost teaching materials on their creativity?
5. What is gender difference in the impact of teaching low cost materials on students’ Achievement in Chemistry?
6. What is gender difference in the impact of low cost teaching materials on students’ attitude towards chemistry?
5.2 Overview of the Research Design

In order to achieve the above mentioned objectives, a test of creativity in science was developed to measure the creativity of the students. Besides the test of creativity, a test of achievement with items taken from the textbook of grade 12 (Chemistry), Test of Science-Related Attitudes (TOSRA) extended to Chemistry with six factors (Behavior tendency to learn chemistry, Liking for chemistry laboratory work, Liking for chemistry theory lesson, Evaluation belief about chemistry, Leisure interest in science and enjoyment of chemistry) and two interviews one each for students and teachers were also used for data collection. Two groups of students were formulated and equalized on the basis of their pretest scores, and randomly assigned to the experimental group and the control group by matching them. Quantitative data were analyzed through statistical tests like t-test, i.e., Mean, Standard Deviation; while qualitative data from interviews was analyzed using qualitative data analysis techniques and results from both were discussed in the previous chapter. The use of both qualitative and quantitative data was aiming to get a triangulation for greater insight on the problem and capitalize the strength of both types of approaches in research. This chapter discusses the findings, conclusions and recommendations in forthcoming sections.

5.3 Summary of the Major Findings

This research posed six research questions. Each is restated below and addressed in turn.

Research Question #1

What is the impact of low cost teaching materials on students’ creativity?

To answer the first question, a validated creativity test was applied to know the impact of low cost teaching material on students’ creativity. Quantitative data analysis approach was used to analyze the data collected through creativity test. Descriptive statistics mean, the standard deviation - test was used to find the mean difference across groups along with Cohen’s D effect size to find the strength of the mean difference.

Key findings of the students’ creativity in both groups, ie, experimental and control group, (as measured by creativity test) were reported in Section 4.1 are summarized below:

- Statistically significant differences existed between the creativity scores of experimental and control group.
• Higher mean scores of the experimental group (M=185.90) shows that experimental group did well in their creativity test.

• Higher standard deviation (SD= 47.050) of control group means that there was variation of score among students than the experimental group, while the lower standard deviation of experimental group indicates that students were focused on activities with low cost material.

• Cohen’s D effect size. Cohen’s d value 0.926 > 0.8 shows that the effect size was found to be larger in the case of the experimental group.

Key findings of the students’ creativity in both groups, ie, experimental and control group, (as measured by sub scales of creativity test) were reported in Section 4.1 (Table 4.2) are summarized below:

• A significant difference was observed between experimental and control groups. Experimental group dominated over control groups in all aspects, i.e., Sensitivity to the problem, Fluency, Flexibility, Originality and Elaboration & redefinition of the creativity test.

• The higher standard deviation of sensitivity to the problem of experimental group means that there was more variation of score among students than the control group indicating that some students were more impressed by the activities with low cost material than their other fellows.

• Flexibility, Originality and Elaboration & redefinition of the experimental group showed lesser variations in the experimental group.

• Cohen’s D effect size values were greater than Cohen’s d value of 0.8 (which represents large effect size comparing two means) showed large effect size in all aspects of creativity.

It can be concluded from these findings that there is a great impact of low cost teaching materials on students’ creativity. Students did not believe blindly in science teaching and conceptualized the basic philosophy of scientific methods. With this approach students produced new ideas, solved the problems, and developed experimental imagination, identifying difficulties and making prediction that are technologically accepted.
The overall positive association between activity based teaching and students’ outcomes of creativity have been reported many times in past research (Shukla & Sharma, 1987; Ramirez & Ganaden, 2008; Upahi 2012; Faiza 2012; Tomasevic & Trivic, 2014), however, this finding warrants further investigation in future research with low cost teaching material.

**Research Question#2**

**What is the impact of teaching low cost materials on students’ achievement in Chemistry?**

A validated test of achievement, comprising of six factors of cognitive domain, i.e., Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation was applied to know the impact of low cost teaching material on students’ achievement in chemistry. Achievement test was constructed by the researcher, consisting of 29 items, each borrowed from previously validated standardized state examinations in chemistry at grade 12th. Quantitative data analysis approach was used to analyze the data collected through achievement test. Descriptive statistics mean, the standard deviation, t-test was used to find the mean difference across groups along with Cohen’s D effect size to find the strength of the mean difference.

Key findings of the students’ achievement of Chemistry in both groups, ie, experimental and control group, (as measured by achievement test) were reported in Section 4.2 are summarized below:

- Statistically significant differences existed between the achievement scores of experimental and control group at 0.05 levels.
- Higher mean scores of the experimental group (21.90) show that experimental group did well in their achievement test.
- The higher standard deviation of control group means that there was variation of score among students than the experimental group.
- Cohen’s D effect size. Cohen’s d value 0.848 > 0.8 shows that the effect size was found to be larger in the case of the experimental group.

Key findings of the students’ achievement in chemistry in both groups, ie., experimental and control group, (as measured by sub scales of achievement test) were reported in Section 4.2 (Table 4.4) are summarized below:
A higher significant difference was found between experimental and control groups. The experimental group dominated over control groups in all aspects, i.e., Knowledge, Comprehension, Application, Analysis, Synthesis and Evaluation.

The standard deviation was lesser in experimental group which means that there was less variation of score among students than the control group. This justified that experimental group focused on activities and did well on their achievement test.

Cohen’s D effect size value shows a large effect size in case of Knowledge, Comprehension, Application and Synthesis, while medium effect size in Analysis and small size in the case of Evaluation.

It can be concluded from these findings that low cost teaching materials were significantly and highly effective for the students’ achievement in chemistry. These results were similar as reported by (Ara, 1998; Khitab, 2004; Khan 2012; Mishra & Yadav, 2013)

**Research Question#3 what is the impact of teaching low cost materials on students ‘attitude towards Chemistry?**

To answer the third research question concerning the impact of teaching low cost materials on students ‘attitude towards Chemistry, the modified form of TOSRA (Test of Science Related Attitude) was applied to treat both groups, i.e. control and experimental. The test consisted of six factors, i.e., the Behavior tendency to learn chemistry, Liking for chemistry laboratory work, Liking for chemistry theory lesson, Evaluation belief about chemistry, Leisure interest in science and enjoyment of chemistry has been discussed in section 4.3 by measuring their mean scores and standard deviation.

Key findings of the students’ attitude towards chemistry in both groups, i.e., experimental and control group, (as measured by TOSRA) were reported in Section 4.3 are listed below;

- Statistically significant differences existed between the attitude towards chemistry scores of experimental and control group at 0.05 levels.
- Higher mean scores of the experimental group (132.03) show that experimental group showed well on their TOSRA test.
The higher the standard deviation of experimental group means that there was more variation of score among students than the control group indicating that some students were more impressed by low cost activities than the other fellows.

Cohen’s D effect size was used and its values (0.944 > 0.8 Cohen effect size value) showed that a large effect size in case of experiment group.

Key findings of the students’ attitude towards chemistry in both groups, i.e., experimental and control group, (as measured by sub scales of TOSRA) were reported in Section 4.2 (Table 4.6) are summarized below:

- Experimental group mean scores, on the scale of Behavior tendency to learn chemistry, Liking for chemistry theory lesson, Evaluation belief about chemistry, Liking for chemistry laboratory work, Leisure interest in science, Enjoyment of Chemistry showed greater significant effect on the control group.

- The higher standard deviation of the experimental group of all factors means that there was more variation of score among students than the control group indicating that students were more impressed by low cost activities than the other fellows.

- Cohen’s D effect size showed a large effect size in all factors of attitude towards chemistry. Therefore, there was a great impact of low cost teaching materials on students’ attitude towards science.

The overall results indicated that students were more impressed by the teaching through activities with low cost materials as compared with a control group who received instruction with a trough traditional method and liked to work in chemistry laboratory with low cost activities and had significantly higher performance accuracy in the test and higher attitude towards chemistry. These results were similar as reported by (Smist & Owen, 1994; Townsend 2012; Gnanadesikan et al, 1997; Demircioglu, Gokhan and Ayas, 2005)
Research Question#4

What is gender difference in the impact of low cost teaching materials on their Creativity?

The key to finding the gender difference with student creativity was important to this research. The gender difference with the creativity was determined using t-test has been discussed in chapter 4 section 4.4.

Key findings of the differences between males and females (see Section 4.4), are summarized below:

- Significant differences were found between males and females of the experimental group in a creativity test at 0.05 levels.
- The higher mean score of the experimental group (208.70) shows that female in the experimental group showed better than male in their creativity test with the standard deviation (22.111) lesser than the standard deviation of male which indicates that female students were focused on activities with low cost material.
- A significant difference was found between male and female students in the experimental group. Female students dominated over male in all aspects, i.e., Sensitivity to the problem, Fluency, Flexibility, Originality except Elaboration & redefinition where male students showed better performance.

The result was not unexpected because female students are always keen observers and have the power of competition to be respected among their class fellows and family members as well. Female students dominated male by producing new ideas, developing experimental imagination, identifying difficulties and making predictions. The result supported the findings by Ahmad (2006) who favored females.

Research Question#5

What is gender difference in the impact of teaching low cost materials on students’ Achievement in Chemistry?

Gender has a remarkably great effect on chemistry achievement. Therefore, to measure the gender differences of the impact of teaching chemistry through activities with low cost
materials on their achievement in Chemistry t-test was applied to control and experimental groups.

Key findings of the differences between males and females (see Section 4.5) are summarized below;

- Significant gender difference was found in the experimental group. Female students performed significantly higher than the male in achievement test of chemistry.
- The same trend was found when comparing factors of cognitive domain, i.e., Knowledge, Application, Analysis, Synthesis and Evaluation of achievement test where the female student in both groups dominated over male students except comprehension where male students dominated over female students.

The overall results showed that teaching of Chemistry through activities with low cost materials had a great impact on female students than male. Although female students do not like handling equipments due to shyness and orthodox situation, but they are a keen observer and have enough time to their home work in chemistry and other subjects as well. This result supported the result obtained by Mishra and Yadav (2013), Maccoby and Jacklin (1974), Khartoum, T & Sharma, M (2010), Calsambis 1995, Sayibo-1999, whose results favored girls rather than boys.

Research Question#6

What is gender difference in the impact of low cost teaching materials on their attitude towards science?

To answer the last research question concerning the impact of low cost teaching materials on students’ attitude towards science, gender wise, the mean scores of respondents on attitude scale and sub scales were calculated. T-test was used to see the significant differences among different categories of respondents like male and female.

Key findings of the differences between males and females (see Section 4.6, Table, 4.13) are summarized below;

- The significant difference between the genders (male and female) of the experimental group was found. Female students performed significantly higher than the male in the test of attitude towards chemistry in the experimental group.
• Large effect size indicating that female students had a higher positive attitude towards chemistry than male.
• The greater standard deviation of the male showed that they were more impressed by the activities with low cost material than female.
• Male mean score on the sub-scale of attitude towards chemistry, i.e., Behavior tendency to learn chemistry, Liking for chemistry theory lesson, Evaluation belief about chemistry, Liking for chemistry laboratory work, Leisure interest in science, Enjoyment of chemistry in the experimental group were lesser than female score.

The findings that females perceived attitude towards science more positively than males can be contrasted with past research, such as Ching (2010), Schibeci (1984), Beaker (1989), Weinberg (1995), Waldrip (1994), Francis and Greer (1999), Jones, Howe and Rua, (2000) O’Brien & Porter (1994), Schibeci and Riley (1986), Simpson and Oliver (1985) are all of the opinions that boys have positive attitude toward science. However, some past research indicates more positive attitudes for females towards science than for males (Hofstein et al. 1977, Dhindsa and Chung 1999) and this is consistent with present research findings.

5.4 Summary of Qualitative Data

In this section students’ and teacher interviews are discussed on the bases of analysis drawn earlier in chapter 4

5.4.1 Summary of Student Interviews

Qualitative data was collected through structured interviews from nine students who were selected none randomly. All interviewees received parental permission to participate. Interview questions, which were written by the researcher and modeled after the questionnaire items used in this study, were used to explore student perceptions about creativity, a sense of achievement in chemistry and attitudes towards chemistry, (see interview questions in Appendices B and C). Summary of the overall responses (Section 4.8) is provided in Table 5.1
<table>
<thead>
<tr>
<th>Variables</th>
<th>Outcomes</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creativity</td>
<td>Justification for the use of materials</td>
<td>Students had made justification for the use of extra materials to the presented apparatus fabricated with low cost material</td>
</tr>
<tr>
<td></td>
<td>The use of chemicals / Solving of problems</td>
<td>Most of the students had inconsistent views about the use of chemicals in the laboratories to overcome the problem for the production of CO₂</td>
</tr>
<tr>
<td></td>
<td>Development of low cost Apparatus</td>
<td>Students explored and shared the use of other activities with low cost material. They explained numerous examples of low cost activities that connected to the concepts recently learned in the classroom or used an introduction to concepts learned subsequently.</td>
</tr>
<tr>
<td>Achievement</td>
<td>Understanding of chemical Process</td>
<td>Students found the content challenging and had no difficulty explaining the concepts and achieved well in topic.</td>
</tr>
<tr>
<td></td>
<td>Learning with low cost Material</td>
<td>As regards learning with low cost material, all students were consistent with the remarks that they learnt more with this approach. The conversation reveals that student had a very strong belief and knowledge about activity with low cost material and considered it an important and useful way learning of chemistry in class.</td>
</tr>
<tr>
<td></td>
<td>Difficulty in understanding Apparatus</td>
<td>Students showed clear understanding of the work done in Nelson Cell. They had developed their conceptual understanding to learn concepts meaningfully. The misconception and difficulties that had been developed in traditional lecture method removed. Consequently the students felt no difficulty</td>
</tr>
</tbody>
</table>
Perception about Improvement

Regarding the improvement of the students with low cost materials in this class, the students had consensus among them that the whole class had improved themselves with this approach to produce new ideas.

Attitude Towards Chemistry

Teaching of Chemistry

All students described their enjoyment of science classes. According to students the teaching of chemistry is an activity based approach; it should be taught by activity. This method makes chemistry an interesting subject.

Teaching with low cost activities

The student made justification and argued in the favor of activities with low cost materials and considered that the best and easiest approach towards science.

5.4.2. Summary of Teachers Interviews

For greater insight on the problem three chemistry teachers from the same institution were interviewed. The main objective of the teacher interviews was to find the conception about teaching through activities with low cost material and their observation about the characteristics of students’ creativity, achievement and attitude towards chemistry. A summary of the overall responses (See section 4.9)

Regarding the conception of creativity the teachers were not consistent. Only one teacher was able to respond, described creativity in the form of giving new ideas which is the original concept of creativity similar to the definition described by Torrance (1962) and Vernon (1989). The assessment of the conception about aspects of creativity revealed that teachers were unaware of the various aspects of creativity.

Regarding the adoption of teaching methods in class they opted to teach chemistry through the lecture method because the course was almost lengthy and the classes were overcrowded. However, they had a better opinion of activity based teaching, especially teaching with low cost material to give new ideas and take care of improvement in the form of asking new questions.
According to them the laboratory situation was not good, the apparatus and equipment were not adequate in science laboratories. A considerable singularity was found in the direction of responses from teachers when asked about the improvement of the students with low cost materials in class. The whole class had improved themselves with this approach to produce new ideas. They worked in groups to share ideas freely and used their textbook effectively.

Regarding the fabrication of low cost activity, a poor response was found from the teachers. Only one teacher could fabricate the low cost activity.

Last question from teachers in the interview was aimed to know the gender difference; there was complete consensus among the teachers that female students were better than male with remarks that female students were more sensitive, studious and motivated to undertake investigative activities.

5.4.3 Gender Differences and Observation Check List

Fifteen aspects of observation checklist were observed in this study i.e. Keenness / interest, additional thinking, frequency of questions, asking of appropriate questions, notes taking, participation /discussion, motivation /eager to try new activities, organization of material/activities, communication/express ideas clearly and effectively, cooperation /work well with others, ability to work independently, following of direction carefully, give proper suggestions, assuming responsibility for own learning, response to teacher questions.

Key findings of the differences between males and females (see Section 4.9.1 Table, 4.18) are summarized below;

- In sub scale of Keenness / interest, additional thinking, frequency of questions, asking of appropriate questions, notes taken, participation /discussion, females dominated males in experimental group, because the females are keen observers, have the power of additional thinking and can compete the problems.
- In sub scale of motivation /eager to try new activities male dominated in the experimental group. Similarly, in the sub-scales of organization of material/activities, communication/express ideas clearly and effectively, ability to work independently, following of direction carefully, give proper suggestions, assuming responsibility for own
learning, response to teacher questions female dominated male in both experimental groups.

- In the sub scale of cooperation /work well with others in experimental group where the male dominated female because female students are always shy and are not active participators in performing activities in the presence of the opposite sex.

It can be concluded from the teachers interview and observation checklist that the better performance of female students showed that females had got much attention from their teachers in the institution and parents at home, therefore, they might work hard to fulfill the aspiration of their teachers and parents. Good academic performance by female students in science subjects had considerable effect on their future life. Due to orthodox and conservative situation of the area the parents do not like their daughters to adopt job except medical line which is considered the best job for them. Furthermore, female students tend to prefer life sciences because they are always interested in human and animal studies. Therefore, in institutions at grade 12 level females are always attentive and get greater attention from their teachers for their devotion to study and trend of competition among themselves. Females tended to perceive most aspects of their science learning environment more favorably than their male counterparts. Both the researcher and concerned teachers observed that, in general, female students were more excited by teaching through activity with low cost material than male students.

5.5 Recommendations

Following important recommendations are drawn on the basis of the findings and conclusion of this particular study. The overall conclusion of this study was derived from the finding of higher difference between the experimental and control group performance and impact of teaching chemistry with low cost activities on students’ creativity, achievement and attitude towards chemistry.
In the light of evidence that teaching of chemistry through activities with low cost material is an effective teaching strategy, the recommendations are categorized for authorities, curriculum designers, teacher trainer and teachers and for students.

5.5.1 Recommendations for Authorities and Curriculum Designers

The scientific knowledge that we utilize today must have creativity foresight and vision, for it has to develop the individual in the competitive world of tomorrow. Five creativity aspects were identified and validated in this particular study through activities with low cost materials. Therefore, it is suggested for the text book developers that particular focus might be given to include hands on activities with low cost materials in the curriculum for higher secondary level to ensure higher creativity of the students at this level.

Another recommendation is to design such low cost material in a curriculum that develops a positive attitude towards chemistry along with students’ creativity and their relationship for better achievement in chemistry, because most instructional time is dedicated to lecture method in class at the expense of activity based teaching which causes more negative attitudes towards chemistry.

As female students dominated over male students in all variables of this study, therefore male students require the attention of authorities. This can be done by including those contents in a curriculum which is equally interesting and can be performed, at least, through activities with low cost material.

Students find curriculum difficult to understand because it is based on rote memorization of the text material. Consequently, they mostly rely on rote memorization and do not gain conceptual understanding. This scenario may be made better by including interesting low cost materials. The teachers may be trained in the proper way for the fabrication of activity with low cost material and their utilization in the class. Both the teachers and students should be encouraged to use low cost materials in the laboratories to learn by doing.
Summarizing, the text book's material may be developed in such way that teachers and students automatically followed the steps of teaching learning process through activities with low cost material.

5.5.2 Recommendations for Teacher Trainers

Although it was found in this particular study that teachers favored activity based teaching but used the lecture method in the class. Therefore the foremost duty of teacher trainers is to prepare the teachers with emphasis on pedagogical content knowledge pertaining to the use of low cost materials to boost up students ‘creativity, achievement attitude towards chemistry. For this purpose they should be exposed to various types of low cost activities. Awareness should be prevailed among teachers by arranging in-service training programs, conferences, seminars, workshops on regular bases.

Chemistry is a compulsory subject at higher secondary level. But at this level the teachers give no attention to refresher courses. Consequently, teacher at this level have no competency of teaching through activities with low cost material. Therefore, it is recommended that the master trainers may equip them with fabrication of low cost activities.

5.5.3 Recommendations for Teachers

From the statistical analysis between the experimental and control groups, it was concluded that the experimental groups showed better performance due to the use of activity based teaching with low cost material. Experimental group produced using higher order thinking such as knowledge, comprehension, analysis, synthesis, application and evaluation in the content area that caused the students lagging in diverging and converging skill. Therefore, it is urgently needed to teach higher order skills at all grade of education with low cost activities.

Creativity leads to motivation for better achievement in science subjects, therefore, all teachers are required to create such atmosphere, while conducting experiments, where students may become active participators and produce diverging thinking to generate new
ideas, alternatives, possibilities that may be useful in solving problems, communicating with others and entertaining ourselves and others.

As teaching science is an activity based approach for which cordial relationship between teachers and students must be developed for full participation of the students in laboratory work. Teachers must cooperate and encourage their students in fabrication of activities with low cost materials for laboratory work. Moreover, they must engage male and female students equally in their laboratory work. Because it is a common observation in most schools and colleges, especially at higher secondary schools, that teachers transmit knowledge without activating students’ energy of learning. Whereas learning takes place when the learner becomes active and indulges himself in the learning process.

5.5.4 Recommendations for Students

The conclusion of this study showed that students who were taught chemistry through activities with low cost materials, improved their performance as compared to other groups who were taught with traditional method. Furthermore, the students in the experimental groups showed their full participation and attended the classes enthusiastically and tried their best to fabricate low cost activities related to the contents. Therefore, students need to be skilled learning process while completing the assigned tasks. Students should be skillful and generate more information by elaborating it.

Activity based teaching with low cost material is recommended for all types of students, whether they are high learners, slow learners or average learners which increase students' creativity, achievement and attitude towards science.

To develop the spirit of fabrication of low cost materials belonging to the content of their text book there should be a competition among the students of schools and college level. With this trend of competition, students will get new direction of learning of science which will become a part of the science curriculum, on the bases these competitions of fabrication of low cost material science courses will be restructured and special focus would be placed on how to develop low cost material science laboratories.
5.6 Suggestions for Further Research

Although the present study found that teaching through activities with low cost material had a great impact on students’ creativity, achievement and attitude towards chemistry, this topic never ends to explore new dimensions. Suggestions for future researchers are presented as follows;

(1) This particular study was conducted on grade 12 Chemistry with some selected topic. Further research can be replicated to other topics of this particular level as well. Similarly, research can be done in other scientific disciplines such as physics and biology as well. This research can also be replicated in the same level in other provinces of Pakistan, in such a case the same tools can be used with modification according to context.

(2) It is suggested that such type of research on the effectiveness of low cost material in teaching science should be conducted at primary, middle and secondary school levels as well.

5.7 Limitations of the Study

The researcher considers that this research has the following limitations which are definitely worth mentioning.

First limitation is, of course, that this study was confined to grade 12 Chemistry subject only, while in Pakistan Physics, Biology and Mathematics are also taught at higher Secondary as compulsory subjects as well.

Secondly, the sample was drawn from a single institution; therefore the study could not cover the whole population. Likewise, the sample was drawn from pre-medical and pre-engineering science stream and ignored inter science students (students study computer science as optional subject) thus the study may not be generalized to this group.

Thirdly, the course of grade 12 Chemistry is very lengthy which could not be covered in days, but in months, so the researcher had to teach the selected topics in prescribed periods
using activity based teaching strategies with low cost activities, therefore the entire course was not taught.

Fourthly, due to the orthodox situation of the area the researcher could not manage to audio taped interview of female students, so the interview was received in written form in the absence of the researcher.

5.8 Implications of the Study

Being a mixed method research, this study has important implication on theoretical and practical grounds. On the theoretical idea this study has strengthened the idea contributing the theories of creativity. Furthermore, the strong impact of teaching chemistry through activities with low cost material on students’ creativity, achievement and attitude towards chemistry indicates that this method of teaching can be adopted and low cost material can be treated alike in contents of test book.

On the practical side, teaching with low cost material has an impact on cognitive determinants.ie, knowledge, comprehension, application, analysis, synthesis an evaluation of chemistry achievement. This contribution leads the teacher to focus on their instructional activities to enhance students’ creativity, achievement and promote their conceptual understanding of chemistry.

As the teachers mostly used the lecture method in their classes to teach chemistry which leads to rote memorization of the text material, therefore, teacher trainers are informed to train the teachers in the context of developing their skill of using low cost material leading to better performance of students in the subject of chemistry. A proper training of fabrication of low cost material might be helpful.

Having the importance of activities with low cost materials, the policy makers and curriculum designers are informed to include such types of activities which can be easily fabricated for better performance of the students in chemistry and to increase the capacity of
the students to observe things in scientific ways to generate new ideas, inventions that can be judged by experts as high scientific, social or technological value. Society needs creative persons, economists and engineer to find a solution to the logical and global problem. This is possible due to strong curriculum which gives new directions to their students.

Activities through low cost material provide pleasure and interest in classroom situation which improve the academic performance of the students for their bright future. This strategy provides the students better opportunities to get mastery in a particular unit/content before going for further study.