EFFECTS OF 5E'S INSTRUCTIONAL MODEL ON ACADEMIC ACHIEVEMENT IN 10th GRADE CHEMISTRY

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A thesis submitted in partial fulfilment of the requirements for the Degree of Doctor of Philosophy in Education at the Department of Educational Leadership & Management, Faculty of Education, International Islamic University, Islamabad.

Department of Educational Leadership & Management
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In the Name of Allah, the Most Gracious, the Most Merciful

DEDICATION

I cordially dedicate my research endeavour

To
My parents and family
Members

FORWARDING SHEET

This thesis entitled "EFFECTS OF 5E'S INSTRUCTIONAL MODEL ON ACADEMIC ACHIEVEMENT IN 10th GRADE CHEMISTRY" submitted by Irshad Hussain in partial fulfilment of the requirement for the Degree of Doctor of Philosophy in Education has been completed under my guidance and supervision. I am satisfied with the quality and originality of student's research work.

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DECLARATION

I, Irshad Hussain S/O Anwar Hussain, Registration No.(141-FSS/PHDEDU/F17), a student of Doctor of Philosophy in education at International Islamic University Islamabad, do hereby declare that this Thesis entitled "EFFECTS OF 5E'S INSTRUCTIONAL MODEL ON ACADEMIC ACHIEVEMENT IN 10th GRADE CHEMISTRY" Submitted for the partial fulfilment for degree of Doctor of Philosophy in Education, is my original work and has not been submitted or published before and shall not in future be submitted by me for obtaining any degree from this or any other University or Institution.

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ABSTRACT

There are different instructional models that teachers adopt for teaching different subjects to students. Among all those, a student-centred model is 5E's instructional model. This model concentrates on engaging students, making exploration through students, explaining and elaborating the learning concepts by students and then evaluating students' learning. The purpose of this experimental study was to find out the Effects of 5E's Instructional Model on Academic Achievement in 10th Grade Chemistry. The research design was true experimental in nature, based on the pre-test, post-test equivalent group design. The population of the study was comprised of all the students (boys) of 10th class studying at secondary level which was administered by Federal Directorate of Education, Islamabad. The sample of the study consisted of 80 students taken from one boys' school by simple random sampling technique. The sample was further divided into two equal groups by equating them on pre-test scores. One served as the control group while the other was experimental group. Three units of the Chemistry textbook for grade 10th were used for intervention. The researcher developed 24 lesson plans in the light of 5E's instructional model and the same number of lesson plans were developed for the traditional teaching method. The experimental group was taught by 5E's instructional model while control group by traditional teaching method. After the completion of eight weeks of treatment, a post-test was administered to both groups. The retention test was also administered after four weeks, from the post-test. The researcher developed the research instrument which was used for the pre-test, post-test as well as the retention-test. This test was developed under the instructions of the 5E's instructional model. The research instrument was developed under the supervision of a supervisor and co-supervisor. This research instrument was validated by the subject specialists, academicians and assessment experts. It was found reliable through the split-half method in pilot testing. In the end, data were collected and analyzed. Mean, standard deviation and t-test were used for data analysis. Data were analyzed by applying a *t*-test at a .05 level of significance. The major findings of the study were that the overall academic achievements of the experimental group in the post-test and also in the retention test taught with 5E's instructional model enhanced significantly as compared to the control group. The study also found a significant increase in different aspects of the cognitive domain of students' learning; knowledge, application, comprehension and skill development abilities of the experimental group taught with 5E's instructional model.

Keywords: Instruction, Model, 5E's instructional model, academic achievement, Chemistry.

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LIST OF ABBREVIATIONS

ANOVA	Analysis of Covariance
BCS	Biological Curriculum Study
LTM	Learning Type Measure
STEM	Science, Technology, Engineering and Mathematics
MANOVA	Multivariate Analysis of Variance
TSI	Teaching Style Inventory
SPSS	Statistical Package for Social Sciences
SAT	Subject Achievements Tests
FCE	Federal College of Education
AIOU	Allama Iqbal Open University
UK	United Kingdom
USA	United State of America
MCQs	Multiple Choice Questions
NEP	National Education Policy
FBISE	Federal Board of Intermediate and Secondary Education
SCIS	Science Curriculum Improvement Study

CHAPTER 1
INTRODUCTION

1.1 Background of the Study

Education plays an important role in the development of any nation. The progress of the nation depends upon the standards of education, especially of science education. Quality of the teaching and learning process strengthens the quality of education. Teaching and learning processes go side by side and both have proper place and importance. According to traditional teachers, teaching is the act of communicating information to the learner in the classroom. Since the start of the twentieth century, research on teaching has provided knowledge about skills, methods, and models usefully employed by teachers for the promotion of students learning. Teaching encourages and stimulates learning to achieve the desired educational goals in the learning domains of knowledge, skills and attitudes etc. (Gloria, 2014). According to Shaheen et al. (2015), the science education develops interest among students by supportive inquiry-based skills, to discover new horizons. The learners inquire about knowledge as an entertaining activity and use their understanding and skills to work independently or collaboratively for common well-being.

Chemistry is taught at the secondary level as a science subject in Pakistan. Its inclusion has been rendered necessary as a science subject for nation-building. As a subject, chemistry and chemists are linked to everything on earth in an appropriate way as what on earth is not chemistry? Chemistry also plays a vital role in the sustainable economic growth of any nation. The importance of chemistry in the development of any nation cannot be underestimated especially in agriculture and industrial states like Pakistan (Khalid, 2012).

The poor performance in chemistry is caused by many factors like poor teaching methodology and improper use of instructional materials, large class size, lecture method, untrained teachers, poor vocabulary and students poor comprehension level of basic concepts of chemistry, teaching chemistry not in native languages of the students and difficulty of chemistry courses as a result of use of lecture method. Traditional teaching method is the major cause of poor performance in science subjects especially Chemistry (Pane, 2018).

Science has many branches like Chemistry, Physics, Biology, Agricultural, Medical Sciences, Health Sciences, Geographical Sciences, Mathematics and Anthropology. Chemistry occupies an important place and position in secondary school curriculum which when applied in any society can bring rapid national development. Chemistry equips students with skills for themselves and their environment. It is a subject required in every day matters (Ewing, 2012). Chemistry as a subject is important to many related disciplines such as Medicine, Nursing, Biology, Pharmacy, Computer, Geology, Law, Petroleum Industry, Agriculture, Paint, Fibre Industry, Leather and Shoe Industries etc. Without Chemistry, no discipline is studied in a better way by any student (Ibrahim, 2015).

Keeping in view the vital importance of Chemistry in national development, researchers, Chemistry teachers, science teachers and other agencies are trying to encourage achievement in Chemistry. Despite this, students cannot perform well without a better understanding of Chemistry in secondary classes (WAEC, 2010). Some researchers reached to the conclusion that Chemistry is important at the secondary level especially, in public schools (Njoku, 2009) while Adesoji & Olatunbosu (2008) were of the opinion that students have misconceptions about Chemistry concepts which leads students' poor performance in Chemistry. These are due to instructional approaches

used by science teachers in their teaching. There is a dire need for the proper teaching of Chemistry curriculum in secondary schools.

According to Sen & Oskay (2017), Chemistry teaching is a particular field that demanded new research and innovation toward the latest approaches. It is a fact that today is the age of science and technology and to provide quality education is the need of time. Changes are continuously occurring in the world of science and technology. It is inevitable to compete with advanced countries in educating various new teaching-learning methods and 5Es instructional model are being applied in developing as well as in advanced countries.

The 5Es instructional model was developed in the late 1980s as part of the living science and living curriculum created through the Biological Curriculum Study (BCS). Bybee & Lamdes (1990). Bybee's famous 5E framework has been adopted by different educationists and researchers as a basic tool to check the effect of the instructional model on students' academic performance and other related aspects. Bybee (1989) developed his famous 5E framework for carrying out learning experiences effectively in a classroom setting. This framework consists of five processes formerly known as to engage students to explain, to elaborate new knowledge, information and to elevate their skills.

The traditional teaching method is used by a majority of teachers in Pakistan for teaching all subjects, the researcher compares this method with the 5Es instructional model to see the effectiveness of the inquiry based 5E's instructional model in Chemistry at the secondary level. The traditional teaching model, as described by Adam & Engelmann (1996) is widely applied to enhance teaching-learning process. The teacher-centred model consists of different steps, followed by people specially and slowly in order to achieve the objectives comprehensively. Various steps like

introduction, development, guided practice, closure, independent practice and evaluation are part of the model.

1.2 Rationale of the Study

Pakistan's (National Education Policy, 2017) sustains the conceptual clearance of basic life skills. Secondary education is therefore crossroad, opening awareness of higher education and equally providing skilled manpower for the job market. Sciences and Mathematics among additional components form the fundamental courses, General Science is a compulsory course for the humanities group and at this stage, and the students are measured as critical intellectuals as they notice the physical world around them. This permits them to think logically and review what is taught in the classroom. This furthermore facilitates them to eliminate mistakes about scientific phenomena. Currently, the countries are concentrated on scientific education, hence Pakistan being a developing country, desires curriculum-based scientific education to encounter the standards of developed countries. It is essential to emphasize teaching and learning from secondary to higher secondary level, there is a need for curriculum that must be knowledge-based and should reflect scientific aptitude in students (Zareen, & Kayani, 2014). It is noted in a local study that the traditional methods of teaching and training are not enough to meet the desires of individuals and their development to become creative members of society (Chaudry & Ayyaz, 2016).

Chemistry provides opportunities for people to engage in logical thinking, in-depth learning, and the development of concepts related to science. It helps students to understand the importance of simplification for appropriate behavior. Advanced thinking is necessary for effective teaching of chemistry, including proper planning of content, objectives, methods, teaching aids, and evaluation methods (Gloria, 2014). Arends (2004) was of the opinion that teachers have a great influence

on children because they develop their courage, and interest, and provide them with useful knowledge about the worldly domains. He further explained that all students do not learn in the same manner so certain teaching methods, instead of a single method are recommended. The key objective of teaching Chemistry at secondary schools is to enable the learners to improve their understanding and skills in chemical science and plan their efforts in education to be beneficial to them and society in general. Even though the importance of chemistry, observation of learners, and improvement in chemistry in the secondary school examination express that only a limited number of students perform well in the examinations (Melese W, 2015).

The inquiry-based teaching method offerings learners with a problem to be resolved and also enhances their motivation. Nevertheless, inquiry–based learning actively involves the learners in the learning practice and permits the learners to study the contents on their own, which offers additional chances for the learners to gain a deeper understanding of the concepts and become better critical thinkers (Wang & Posey, 2011). The 5Es instructional model encourages the scholars' interest and creativity (Rasul et al., 2019). Acids, bases, salts, water, and the atmosphere are the areas of difficulty for students in Pakistan. The researcher focuses on determining the difficulties in Chemistry faced by students due to teaching methods. It is important and complex for parents to handle this task. Modern society needs highly expert teachers in methodology to provide positive instruction. With experience in the profession, they should help students by using best practices to impart knowledge, skills and attitude.

1.3 Statement of the Problem

Chemistry is the science of finding information about an innate phenomenon in an empirical way. It is generally obtained by using a specific method for a certain area, which can lead us to keep up with the knowledge about that specific phenomenon. It is

examined that science teaching models are gaining popularity all over the world these days and are being used in science teaching at various levels such as primary, secondary and tertiary levels. Although these models may have been used in our educational institutions for a long time, systematic examination of their intentional use and corresponding effects on student learning, achievement, and attitudes toward science has yet to be explored. Considering the importance of such models, the researcher intended to investigate the effects of the 5E's Instructional Model on Academic Achievement in 10th Grade Chemistry.

1.4 Objectives of the study

The study focused on the following objectives:

1. To investigate the effect of 5E's Instructional Model on students' academic achievement in 10th grade Chemistry.

2. To find out the effect of Traditional Teaching Method on students' academic achievement in 10th grade Chemistry.

3. To compare the effect of 5E's Instructional Model and Traditional Teaching Method on students' academic achievement in 10th grade Chemistry.

4. To compare the effect of 5E's Instructional Model and Traditional Teaching Method on the students' retention in 10th grade Chemistry.

1.5 Hypotheses of the Study

The null (statistical) hypotheses of the study were:

Ho1: There is no significant difference between the mean pretest scores of students' to be taught chemistry with 5E's Instructional Model and with Traditional Teaching Method.

Ho2: There is no significant difference between mean posttest scores for students' taught through 5E's Instructional Model and Traditional Teaching Method.

Ho3: There is no significant difference between the mean retention scores for students' taught through 5E's Instructional Model and Traditional/Rote Teaching Method.

1.6 Significance of the study

Chemistry is a difficult subject that owes to its intrinsic and particulate nature. This problem of difficulty and concept can be resolved if it is presented and taught logically and according to the psychology of students. As the present study is concerned, it has great significance, as it will be helpful to evolve an effective model for teaching Chemistry at the secondary level from Pakistani perspective. The current research study may offer openings to the learners for constructive growth of innovative knowledge and skills created on their prior concepts from the use of the 5Es instructional model. This model will also stimulate inquiry-based learning rather than traditional rote memorization of the scientific perceptions. This model motivates students to improve their understanding and perceptions of the themes. It will be helpful to encourage secondary school teachers the practice of the 5Es instructional model in lesson planning to offer worth teaching to their students. Furthermore, it supports the practice of different strategies by assisting an integrated teaching approach. It will be supportive for retaining knowledge for a longer time by the use of the 5Es instructional model in teaching. It will be helpful to motivate teacher trainers to reshape their training programs. The findings of this study will be useful for policymakers as it may provide them an opportunity to rethink and remodel their priorities. It will hopefully help the organizers and implementers and will enable them to develop effective strategies and

action plans in the future for improving the quality of Chemistry education at the grassroots level. Moreover, the forthcoming researchers will also gain insight into exploring further aspects of the area being addressed by the researcher.

1.7 Delimitation of the study

1. The study was restricted to public sector secondary schools which are working under the Federal Directorate of Education, in Islamabad.
2. The study was further delimited to the boys' secondary schools only.
3. The study was also delimited to the specific syllabus from 10^{th} grade Chemistry textbook that was selected for experimentation.

1.8 Operational Definitions of Major Terms

Instruction

A set of events that facilitate learning.

The process of guiding the learner to gain knowledge, skills and understandings, by the instructor as a result of interaction with learners.

Model

Model is a theoretical way of understanding a concept or idea.

Academic Achievement

Academic achievement is the extent to which a student, teacher or institution has achieved their short or long-term educational goals.

5E's Model

One of many instructional approaches that support inquiry-based science teaching is the 5E's instructional model, which includes five specific components:

- Engage
- Explore
- Explain

- Elaborate
- Evaluate

1.9 Conceptual Framework of the Study

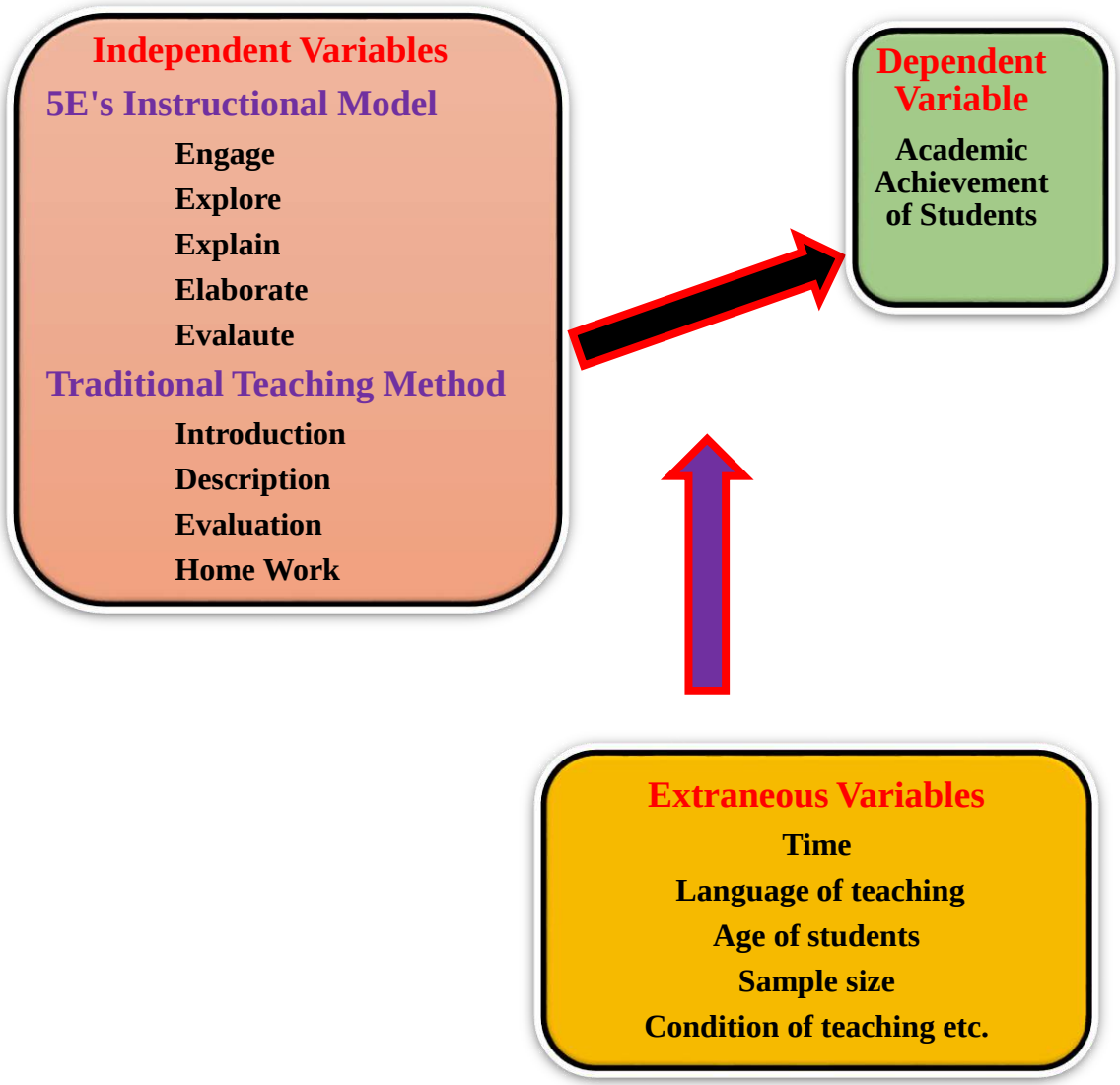

Figure 1.1 Conceptual framework of the study

The above figure shows the framework of the entire experimental study. It describes the perception of the researcher about the variables in the simplest way, and how they built the relationship between them. The academic achievement of students in Chemistry was included in the list of dependent variable, while treatment through

the 5Es instructional model and traditional teaching method was considered as the independent variable. It was hypothesized that the dependent variable might be influenced by the independent variables and that it would improve after treatment. Various extraneous variables such as time, language of teaching, age of students, sample size and condition of teaching etc., were also not ignored. According to Gay (2009) to control for extraneous variables simultaneously, randomization is the best method alone. Therefore, a true experimental design was used for the research to control extraneous variables.

1.10 Procedure of Research Study

The following steps were taken by the researcher to conduct the study.

1.10.1 Population of the Study

In this study, the target population consisted of all 10^{th} grade boys' science students enrolled in 77 Boys Secondary Schools which were administered by the Federal Directorate of Education, Islamabad. The target population could not be reached. Therefore, the researcher defined the available population of this study.

1.10.2 Sample and Sampling Technique

Only one school, Islamabad Model School for Boys (vi-x), Noor Pur Shahan was randomly selected for the study. All the students of 10^{th} grade (80 Boys) studying the subject of Chemistry at that school were selected as sample of the study. The class was divided into equal groups experimental and control groups.

1.10.3 Research Instruments

The achievement of 10^{th} grade students studying chemistry was measured by applying the pre-test, post-test and retention test developed by the researcher. The pre-test was developed under the supervision of a supervisor and co-supervisor. The pre-test was constructed according to the selected syllabus. This research instrument was

validated by the subject specialists, academicians and assessment experts. Reliability was confirmed through the split-half method.

1.10.4 Data Collection and Data Analysis

Data from the study consisted of the scores achieved from the pre-test, post-test and retention test of 10th grade students. After scoring the responses of students on pre-test, post-test and retention test SPSS, version-22 (Statistical Package for the Social Sciences) was used. After collecting data from the students, the data were analysed. The descriptive analysis was used to calculate the measures of central tendency (mean) and measures of dispersion (Standard Deviation). The researcher applied a dependent *t*-test to compare the achievement of students of the same group in the pre-test and post-test. Another inferential statistic test was used called the independent sample *t*-test, which is a statistical test to compare the achievements of experimental and control groups and to determine the significant difference in both groups. Pearson correlation coefficient (*r*) was also used to find out the strength of the relationship between the groups.

CHAPTER 2
LITERATURE REVIEW

This chapter includes a review of related literature that helped conduct the present study, as well as a thorough discussion of the inquiry-based 5Es instructional model. Discussion and review begin with the constructivist methods, which are based on constructivism theory. In addition, the 5Es instructional model, traditional teaching model, Marzano's taxonomy, Bloom's taxonomy of educational objectives, personalized learning, and different models of teaching science are described with their specific elements. Lastly, the different research studies are discussed that are related to the 5Es instructional model.

2.1 Introduction

Globalization has become increasingly important around the world in recent years. It has affected the education system, creating many challenges for teachers in how they deliver lessons. Because of this, changes in teaching methods are needed to create a new approach that fits the needs of students in a globalized world. This new approach should focus on developing ways for students to continue learning throughout their lives. This is important not only to meet the challenges of globalization but also to offer an alternative to the traditional way of education, which mainly focuses on giving knowledge and skills to local communities (Shaheen et al., 2015). Teachers are expected to teach their students according to the manner set by the government of Pakistan, Ministry of Education (2006), but most teachers teach science traditionally. They follow textbooks or lab procedures for driving instruction and they do not consider students' ideas in instruction. While so many do not utilize studies that support the use of inquiry. Arrangements of non-traditional instruction which is inquiry-based are complex and many teachers do not accept this type of learning. Many educators revert due to the complexity and lack of instruction in scientific inquiry techniques not fruitful

for the students. Teachers' views and actions need to change. The gap has increased more and more because theory and practice are there to be dealt with separately (Duit, 2006).

Chemistry is a natural science taught at the secondary school level in Pakistan and around the world. The importance of chemistry cannot be overstated, as it is essential to science as a whole. The scientific progress of a nation is often determined by the quality of chemistry education in its schools (Okafor, 2003). The main goals of teaching chemistry in secondary schools are to help students develop their knowledge and skills in chemistry and to encourage them to apply their education in ways that benefit both themselves and society. Despite its importance, students' performance in chemistry exams at the secondary school level often shows that very few students do well (Melese W, 2015).

This frequent poor performance suggests that something may be wrong, either with the content being taught or with the way it is being taught. The main goal of teaching is to transfer knowledge to students. Chemistry teaching should be results oriented and students centred, using the right methods and resources. In chemistry classes, students should learn both concepts and practical skills (Colburn, 2009). According to Uce (2009) Chemistry teachers recognize that students often struggle with abstract concepts, yet most classrooms do not address the need for students to develop proper mental models. For students to fully understand these abstract concepts, teachers must choose appropriate teaching methods. Chemistry's abstract nature and related learning challenges require high-level skills and thinking (Taber, 2006).

Research by Oliver (2007) and Prince & Felder (2007) showed that inquiry-based teaching increases student motivation by presenting problems for students to solve. Inquiry-based learning actively involves students, allowing them to learn on their

own and gain a deeper understanding of concepts, becoming better critical thinkers (Wang & Posey, 2011). The 5Es model stimulates interest and creativity (Rasul et al., 2019). Metin et al. (2011) found that prospective teachers believe students in a constructivist environment want to learn. The 5Es model helps students grasp topics, guiding teachers on what and how to teach. Retention of concepts is improved with constructivist models, particularly the learning cycle model, as supported by related research. Fazelian & Soraghi (2010) noted that the 5Es instructional design effectively increases students' learning levels.

Ürey and Çalik (2008) suggested that using just one method to correct science students' misconceptions is not entirely effective. Instead, combining different methods within the 5Es model may better improve students' understanding and help eliminate misconceptions. The 5Es instructional model could be made more effective by integrating it with newer techniques. Many studies have shown that students struggle to retain knowledge when it is taught through traditional methods. The 5Es instructional model is a modern and active learning approach that is essential for effective learning (Ahmad et al., 2019). According to Daşdemir (2017), blending the 5Es model with animations has been more successful not only in teaching science concepts but also in enhancing students' understanding. In this study, the constructivist teaching approach, 5Es instructional model and traditional teaching method employed to find the effects of 5E's instructional model on academic achievement in 10^{th} grade Chemistry.

2.2 Constructivism Theory

The theory is based on obtained knowledge by learner through proper instruction. (Kirschner et al., 2006). According to this, a person has established an idea to comprehend and understand the environment, their experiences, and whatever they have received (Van Manen, 2015). When learners know about the new information they

compare it with past ideas and experiences and afterwards accept or reject the new information and new knowledge the way they obtained it. It is on the basis of the theory that human beings are active in knowledge creation. Learners should collect information, ask questions, and keep involved in the exploration of their environment, whatever they have achieved (Boud, 2013). This theory enables the learners to use proper and active methods of learning i.e. experiments, involvement in discussion and solution of problems. Learners are enabled by learning techniques to what to do and to get the output to a great extent. The instructor played the role of understanding the students' pre learning ideas to balance the activities of classroom and build the student's ideas in promoting learning (Kolb, 2014). The skilful teacher encourages students and ensures their involvement in self-assessment of their own activities for the promotion of better comprehension. Learners are expected to improve their work and accomplish their ideas as well. Expert learners are those who indulge them in learning activities through their motivation. If the activities in classroom are of different types then classroom provide a good learning environment (Nelson, 2013).

Constructive minds are deep-rooted in psychology and philosophy (Mertens, 2014). Constructive process has enabled several scholars to be credited for this purpose. Those scholars are Piaget, Vygotsky and Bruner, Gibson, Goodman, Dewey, Fouccultand Thomas Kuhun (O'Connor, 1998). Piaget Concentrated on the development of mathematical and logical concepts. He also developed his theory on concept of cognitive structure formed by people while they are reasoning. Piaget is of the view that people used cognitive structure which are forms of physical and mental reasoning related with specific acts and response regarding child development (Beard, 2013). Piaget also presented four principles on the basis of his studies; he argues that children give different explanation according to their thinking. When learning

environment showed to be challenging with many activities. So cognitive development is promoted in this way. This is a way by which learner becomes able to engage (Assimilation and accommodation). The learning materials should be organized in a way which coordinate with the mental approach; the students should not be given tasks beyond their capabilities and capacities. Learning should make use of instructional methods, presenting the learners ideas be challenged and be made active (Derry, 1996).

Vygotsky concentrated on context of language learning in children (Lantolf et al., 2015). Vygotsky how social interaction provided an important role in the development of cognition and came with the following principles of learning. The level of development in children is restricted to limited range at any given age but cognitive development can be gotten if students are given chance of social interaction (Butterworth, 2014). Vygotsky (1980) said that learning and development are one and the same thing which can't be separated and further explained that the process of socialization and education help in promoting learning development in children. According to Vygotsky culture played a role in provision of cognitive tools that transforms the perception, attention and memory ability of children. The cognitive tools provided in culture include history, social context, traditions, language and religion. According to assumption, learning occurs when children make full use of social environment by interacting with others and internalize the experiences. It is also earlier notions of a child having new experience resulting from interacting with others in the environment leading to new ideas. Vygotsky presented a classical example of pointing a finger (1978) explaining that when a person points a finger by explaining behaviour which begins simple responding and clearly elaborated gestures. As a result of communication of ideas that social and culture context play a role with the process of cognitive domain. The contribution of Vygotsky constructivism is referred to a social

one (Kim, 2001). Bruner's view regarding constructivism based on the learners constructed frame ideas which are based on existing knowledge. According to Bruner's theory learning involves that learners get something from their learning process. Bruner described the process of learning consisted of various dimensions including selection and transformation, making new decisions based on the information gathered, new assumptions got from information collected and making meaning from the received information and experiences shared (Sivan, 1986).

Bruner's theories stressed on the importance of different categories in learning (Bruner, 1966). He assumed firmly for people who feel and perceive that to categorize while making decisions (Bruner & Austin, 1986). Furthermore, Bruner's assumption explained that information and experiences are interpreted having base on differences and similarities of learners experiences (Jonassen & Hernandez-Serrano, 2002). Bruner's view about learning is an active process according to which learners form new methods of reasoning to put them into consideration based on current and past knowledge (Duffy & Jonassen, 1992). Learner should select new information based on decision about his cognitive structure. Bruner's three learning principles- learners' prior knowledge -learning environment for learners -instruction should be easily commanded by learner and learner should fill all gaps related to the learner approach and capability and provide space for concluding something new (Sivan, 1986).

2.3 Constructivist Instructional Methods

These constructivist methods of instruction permit learner to be close to learning environment by taking part in the creation of knowledge. Fosnot (2005) was of the view that new framework under this theory enable teachers for innovation. Students prepare and select materials for the purpose of learning and objectives for the lessons. Teacher in classroom keeps an eye on activities in order to make it sure that in spite of

challenging, they motivate the students. Teacher interacts with the students and ensures availability for provision of necessary material, and information, to the students. Such learning materials concentrate not only on facts but also on bigger ideas. The teachers encourage students in following their own benefits while reaching to the results (Brooks & Brooks, 2001). Assessment of learning outcome is a continuous process in the constructivism. In the process of assessment of learning both students and teachers, show their involvement by using students' portfolios, quiz etc. the constructivist instructional methods need to give chance to learners for knowledge creation. Features of constructivist instruction as achievement of objective, and proper goal attainment by Appleton and Asoko (Trowbridge et al., 2004). A constructive teacher should have clear concept and he/she should put forth goal for the learners to enable the learners how the objectives can be obtained. Thinking skills should be kept in mind. These strategies make the learners to identify pre instructional knowledge of the learners. These methods should also be used for the learners' prior knowledge for reflection of accepted ideas. When questions are asked then conceptual structure is changed accordingly (Meyer & Land, 2013). A constructivist teacher should provide opportunities to the learners to use and establish new ideas. Lastly, learners should perform learning tasks within the realistic environment. Learners should be permitted to give references of textbooks and other material during class and group discussions. Appleton and Asoko mentioned features of constructivist instruction which are similar to Brooks & Brooks (2001) mentioned five pillars on which a classroom is built. The first pillar is posing problems relevant to the learners. If learning task is relevant to learners, they find transfer of learning easy. Learners attach themselves to the relevant learning materials. Secondly, learning process also revolves around primary concepts.

Teachers having constructivist method viewing the learning process to present the learning materials not in parts but in whole. Schank & Abelson (2013) opinion that learners can break whole in to parts so that they comprehend the relation of parts with whole whether relationship is established in balance. The teacher should know the viewpoint of the students. All learners have some previous knowledge about the already gained information. The constructivist teacher requires to know the learners' previous knowledge and elaborate in order to enable the learner to enact new understanding and scientifically accepted knowledge may be reconstructed (Brophy, 2013).

Assumptions and methods are necessary for constructivist learning curriculum. Students held assumptions and ideas as true knowledge (Ewing, 2012). The hypothesis can be regarded as his conceptions that learners hold about the learning material. Learner hypothesis are addressed by involving in instructional methods. The teacher present questions relevance to learner, structure learning materials around elementary perception to value students' viewpoint (Earl, 2012). This approach had its involvement in the analysis of learning (Savery, 2015). Process of instruction requires assessment procedures in the context of teaching and learners work observation is involved and all kinds of interrelations in the classroom.

2.4 5E's Instructional Model

In Democracy and Education (1916), John Dewey supported children rather than the curriculum at the centre of classroom. Dewey saw education as a social interaction between children and adults. He believed that knowledge could not be given to a student but students must be engaged in order to learn (Twyman, 2016). John Dewey was of the view that students must learn more. Students should experience science according to the scientific method. Students should be able to define a problem and its solution. They should have made supposition, observe and evaluate and test the

supposition. Students should follow the defined process in this learning cycle. After completion "hands-on" step, they should use "minds-on" to reflect on their experience (Brown & Abell, 2007).

Atkin & Karplus argued in 1962 that three components are necessary for learning i.e., exploration, term introduction and concept application through the development of Science Curriculum Improvement Study (SCIS), they recognized the original learning cycle for teaching inquiry based science (Atkin & Karplus, 1962). The original learning cycle was based on ideas and work of Friedrich Herbart, Dewey, Atkin and Karplus (Bybee et al., 2006).

Exploration allowed the learners to become interested in the subject by hand, ask question and identify of dissatisfaction in the science curriculum improvement study's model of learning cycle (Tanner, 2010). According to 5Es model, it allowed the students to avail opportunity to practice science and sequence of model for effectiveness (Bybee, 2014). Teachers omitted and shifted the order of the model to make the process effective (Tanner, 2010).

Herbert developed a philosophy of teaching comprising two main components namely conceptual understanding and interest in the beginning of 20th century. Herbart's philosophy was one of the first approaches (Hanuscin & Lee, 2008). Instructional model is a sequential process designed for teaching and learning (Marek, 2008). Students would be given chance of discovery first and then build on prior experiences and knowledge. Teachers would guide the students through experiences. Teachers would also explain the expected result for students through their learning experiences and students are allowed to apply new knowledge to their new experiences. According to Herbert if student discovers science concept, he / she would have more knowledge (Bybee et al., 2006).

The 5E's instructional model was developed in 1987 by the Biological Science Curriculum Studies and five phases of learning. According to 5E's model, learning is an active process of building knowledge than gaining it (Richards, 2015). This knowledge is more personalized to students through use of phenomenon for all students to practice science as they learn (Bybee et al., 2006).

The 5Es model has been used in subjects of science and applied in education (Hu et al., 2017). The 5Es instructional model is often applied in the paradigm of science education and can also be exploited for all subjects. By the use of this model, the student can acquire additional knowledge relate to science content, science progression and critical thinking skills (Soomro et al., 2010). History of researchers tell us that 5Es model is effective in traditional way of life. Concept formation method with 5Es model is more effective as compared to traditional method (Jack, 2017). Students and teachers are allowed to engage in the learning experience and to create meaning learning of what is being taught (Ergin, 2012). Exploration of each aspect of various stages is necessary in the said model. Details of the five stages are below:

Figure 2.1 5E's instructional model by Roger Bybee (2006).

2.4.1 Engaging

Engaging is a stage in which learners are mentally involved in problems, situations or objects through teachers using pre text tasks. According to Zakaria et al. (2013), teachers should involve students in a task to gain knowledge, increase curiosity and establish between past and present learning experiences. Students explore the topic through one or more related activities to challenge their comprehension level of the concept. Teacher should provide necessary information on the subject to the students. Teachers should reveal new experiences to inspire the understanding of students so that they can apply their understanding to the new situation. According to Williams (2019), focussed on content at the expense of process in STEM education (and indeed in all education) will inhibit student learning because important learning occurs through process activities. When learning content is necessary to be able to apply it through an activity to a situation, such content is perceived as relevant and thus will be learned more effectively and efficiently. Bybee (1997) argued that students used previous information about the topic being studied. The previous information is also helpful for solution of problems relative to current topic. Students are engaged to use discovery method for asking questions. Problems can be introduced by defining problem to solve by using actual methods. Teacher plays a role of facilitator. He/she instils the principles when setting a mission. Therefore, the situation of "unbalance" is seeing (Bulbul, 2010).

2.4.2 Exploring

According to (Lawson & Thompson, 1995) learners needed a time frame for the development of concept related to problems. Therefore, exploration based activities are designed to enable learners' engagement in topic and about new skills perceptions or procedural aspects of problem solving. In the start of phase learners used "Balance" for

the solution of the problem (Bulbul 2010). Bybee (1997), described that various methods are used for the teaching learning process. But to support scientific and logical approval of concepts, software should be carefully designed. Students' earlier rehearsals can be explored by the activities so the students, can develop novel ideas, skills and processes to apply them for bringing innovative ideas to gather exploring objects, specific events and situations are the central targets. Students become able to learn new things. As the role of teachers is to facilitate and guide them (Bulbul, 2010). The teacher made this point for learner when the learners tried to comprehend the world around them provided essential condition and time distribution (Bybee, 2006). The idea of the facilitator is reinforced when students rebuild their experiences.

2.4.3 Explaining

The explaining process introduced learners and teachers to the terms used in subsequent works (Bybee, 1997). Teachers strive for attracting the attention of students to reach specific points in the previous stages of participation and exploration. Proper environment is required for sharing experiences by learners. Afterwards, teachers take turns to provide description about science and technology in a clear, direct and formal manner. The exploration arrangement is a so called interpretation (Bulbul, 2010). The teacher asks about connection between experience and interpretation based on the previous knowledge, stage, participation and exploration.

The relevant features provide the essential conceptual knowledge of the topic being studied in simple, flawless, inclusive and upright manner. Bulbul (2010) narrated the teachers can give strategies and techniques and concentrate on successful learning styles and strategies for promotion of students' depiction. Verbal descriptions with collaborating of others tools like course instruments, videos movies and computer applications. This phase allows psychological organization for continuity. This stage

also shows the ability of the students to describe practices based on exploration (Bybee et al., 2006).

2.4.4 Elaborating

The students are required to be involved in experience to widen their thinking about the studied topic. Therefore, the elaboration phase contributes to the transfer of learning (Bulbul, 2010). Learners exploratory phase activities provide learners the opportunity to capture enormous concept with more learning experiences. One of the opportunities is to assess the level of understanding by using the learners' skills. This skill develops self-respective perspective. Students should be provided necessary feedback from the learners (Bybee et al., 2006).

2.4.5 Evaluating

Informal and initial assessment level starts and lasts during the 5Es instructional sequence teacher can conduct formal assessment (Bulbul, 2010). To assess the level of individual understanding being studied (Bybee et al., 2006). The latest research helped students in the learning process to correct scientific concepts, meta-analysis of research (Bulbul, 2010). (Benford, 2001) teachers actively participated in the students' inquiry and reasonable improvement constraints.

2.5 Personalized Learning

5Es Instructional Model is based upon cognitive psychology, constructivist-learning theory, and the practices in science teaching (Duran, 2004). Learning through the use of 5Es instructional model allows students to adopt personalized learning experience for students change their basic concepts through reflection, elaboration, description and rectification (Bybee, 2009). 5Es instructional model gives the students more ownership so that they internalize their learning which is based on their concept understanding.

There was one teacher and one classroom in USA in the 18th century. As the system transformed, grading schools existed. No doubt that the children of the same age could learn the same materials (Gundlach, 2012). Teachers recognized with prior knowledge and students arrive on their first day of school varies to great extent. The needs of children are addressed by using numerous strategies by teachers at different level (Josephson et al., 2018).

Learning experience of students is adjusted with the help of personalized learning models. It is based on strengths, needs and interest (Herold, 2017). In practical field, personalized learning is used. It is a supporting guide and encourages students to become responsible regarding learning and maximizing students' achievement (Easley, 2017). Johns (2018) claimed that four core elements of personalized learning are their (1) flexible content and tools (2) student reflection and ownership (3) data driven decisions and targeted instruction. John says that education should approach every core element for fully utilization of each, merging all four in order to enable learning in a meaningful way. The first one involves teachers merging three materials in personalized learning. Teacher should make these materials adaptive, customizable for individual students (Johns, 2018). Proper level of challenge is made by the help of adaptive content. Customizable content provides students new platforms for demonstration of knowledge. Foundational content provides concepts and exercises, guaranteed to all students (Johns, 2018).

Student strategies promote in vogue students' ownership of comprehension (Johns, 2018). Teachers are required to provide more opportunities for the learning of students. All these consist of monitoring and development and other activities. Students can obtain more ownership due to learning. Final obtained conclusions based on student progress, made by teacher including different programs, evaluations and performance.

Teachers are informed with the help of continuous data collection on specific topics of instructional decisions.

This also gave opportunity to students reviewing their data and make learning decisions (John, 2018). Students' role in data collection further strengthens their experiences. Given and fixed instruction enables teacher to make and alter student groups depending on their self-interest, their requirement and their level of understanding. It specifies the students for better results. Teacher can use different strategies such as to make groups of students for the better understanding. Their skills are encouraged through lessons (John, 2018). Teachers have made efforts to see the needs of students by their interests and their priorities. Personalized learning can be looked into the perspective of overall school level across all areas regarding grades and subjects (Pane, 2018). The enforcement of such personalized learning permitted teachers to transfer educational approaches (Bray & McClaskey, 2013). To explain the active participation of learners in their learning process. Learners provided chance to show their potential about their learning experience. Teachers played a role as guides in the learning process. Students are needed to accept and enhance responsibility for their learning (Bray & McClaskey, 2013).

Teachers have tried to deal individual necessities of the students by including their necessities into instruction. Personalized learning can be seen school vide comb activity of the ideas across grade and subject areas (Pane, 2018). The 5E model promote personalized learning of the students. The 5E model also give progress to together and active learning for the solution of problems by questions, observation, evaluation and drawing results (Duran & Duran, 2004).

2.6 Traditional Learning Model

Traditional typical example of pedagogies basis on rote learning have been for centuries. Mostly teaching is conducted through old conventional ways for transparent results as a result of good performance which stresses the getting of data through learning by heart of fact based material and separate updates. Traditional learning is a sort of programmed learning which is free from comprehension. Traditional learning model is used by majority of teachers for immediate memorization. Mayer (2001) said that main theme of this model is memorizing through retention. Principle of exercise plays the model. In this method students only remind memorized object no matter they understand it or not. The philosophy is only getting information through memorization. So far as teachers' role in traditional learning concerned, the whole process depends on two factors teaching for presentation of respective material and to get previous information whatever he has for the purpose of retention power in students. Adams & Engelmann (1996) said that teachers use traditional learning for teaching for no hard work is involved. Students are responsible to learn and teachers should direct them about the material, to be memorized. Student should be instructed to learn and memorize the learning objectives for achieving the said objectives. Teacher should play a key role to control the teaching learning situation on account of this method large number of contents can be delivered. No need of audio visual aids for teachers but teachers should adopt the ways according to mental approach of students. Rote method is beneficial for preparation of test or learning a formula.

According to Feyman & Leighton (1985) rote learning method could improve students' skills and help in retaining knowledge for fulfilment of tasks. Traditional learning method is preferred in developing countries like Pakistan as it is easy for teachers. Any subject of interest can be taught and learnt by this method. The rote

learning method is mostly used in the institutions of Brazil, China, India, Pakistan, Malaysia, Singapore, Japan, Italy, Turkey and Romania etc. Some of these countries have become successful in this method.

According to Mayer (2001) retaining of formula in learning of math and science traditional learning method could play significant role. Students could seek help in memorization of formula or information as compared to rote repetition. It has been observed that student derive formula himself rather than ready-made formula. Kreitman (1998) presented concept of learning by ear. Difference is there between memorizing and learning through hearing which is indeed considered as a significant skill. Kreitman categorized three learning approaches. They are rote learning, teaching by reading and the third one is learning by ear. All these three methods have been presented by Kreitman (1998).

2.7 Steps involved in Traditional Learning

Traditional learning approach is a continuous process but to make simpler, it can be divided into following steps,

2.7.1 Introduction

Teacher provides feasible environment to the students for the purpose of learning. He asks questions from the students based on previous knowledge.

2.7.2 Development

This step is used for provision of explanation about related topic. For the better understanding question answer technique is used and model and examples are put forward if needed.

2.7.3 Guided practice

Students can find an opportunity of repetition of material and teacher provides guidance in this respect.

2.7.4 Closure

In this stage teacher concludes the target lesson.

2.7.5 Independent practice

To make learning more productive, teacher gives different assignments as a task.

2.7.6 Evaluation

Students' progress is checked through assessment made by teacher.

2.8 Bloom's Taxonomy of Educational Objectives

Bloom's Taxonomy and the 5Es instructional model are complementary in educational settings. Bloom's Taxonomy provides a framework for classifying different types of learning objectives, ranging from lower-order thinking skills (remembering, understanding) to higher-order thinking skills (analysing, evaluating, creating). The 5Es instructional model (Engage, Explore, Explain, Elaborate, and Evaluate) is a constructivist approach to teaching that emphasizes hands-on learning, inquiry, and critical thinking.

Pickard (2007) Bloom's Taxonomy is helpful for both the teaching process as well as assessment process. Anderson & Krathwohl (2001) Bloom has identified six levels of domains. His taxonomy is hierarchical based. In first stage more difficult cognitive activities follow knowledge. This is possible through comprehension, application, analysis and to the complex learning objectives.

2.8.1 Knowledge

This stage is for remembering and recalling information. Students do not comprehend the material. They only learn by heart rather than comprehending it. Anderson & Krathwohl (2001), the behaviour's from students' comprehension level is

to describe, identify, remember, recall and to define the factual position. These words are used to assess the level of understanding of the students.

2.8.2 Comprehension

This stage relates with full command over subject matter. First of all, student have to memorize something without learning by showing predefined level of comprehension. Pickard (2007) was of the opinion that understanding level of the students can be assessed through different actions like describe, choose, comprehend, understand and deduce etc.

2.8.3 Application

Application level comes after comprehension level. Pickard (2007) said that this level is for the students' mental approach and ability through their knowledge in a new phenomenon. Higher level of understanding involves in this one. It means that how students can apply his knowledge precisely for example how they can use words in sentences.

2.8.4 Analysis

Students observe the material, critically. According to Bloom (1956) analysis is the process of splitting up whole into parts so that students go in depth about the composition and features of that whole. This stage is also helpful in knowing and comprehending relations among various things. Students are examined and tested through various words like to contrast, to categorize etc.

2.8.5 Synthesis

This is also interesting and important level by which students are enabled to combine parts to make a whole. Creativity is required at this level in order to make new things. Parts are combined after doing activities for combining parts and manage them

in better way. Bloom, (1956), gave his opinion that students' synthesis ability can be judged by the process of classifying, handling, linking and arranging etc.

2.8.6 Evaluation

This enables students to judge and compare the value of thing or idea with already established standards. Students may suggest the things on priority basis. Teacher can use different words like claim, guess, justify and choose etc. in order to assess the students (Bloom, 1956).

2.9 Marzano's Taxonomy

The Marzano model and the 5Es instructional model both focussed on effective teaching practices but approach them from different perspectives. The Marzano model emphasizes strategies for classroom instruction, such as identifying essential elements, providing feedback, and recognizing student progress. On the other hand, the 5Es instructional (Engage, Explore, Explain, Elaborate, and Evaluate) is a framework for structuring lessons to promote inquiry-based learning and student engagement. While they have distinct elements, they can be complementary as both aim to enhance student learning outcomes through thoughtful instructional design and delivery.

Robert J. Marzano is a well-known educationist who developed a new taxonomy of educational objectives in 2000 to deal with Bloom's Taxonomy and standards of curriculum. Marzano's Taxonomy has a great effect on students' thinking ability and it is more inquiry based. So, it is very useful for the teachers to cope with students' learning problems.

David (2013) said that Marzano's new taxonomy comprises one domain and three systems. The domain is knowledge and the three systems are the following:

i. Self-System

ii. The Cognitive System

iii. The Metacognitive System

These systems are very important for learning and thinking process. For doing a new task, the domain and systems work in chain. First of all, knowledge domain provides content, cognitive system processes the information, metacognitive system sets goal and self-system decides whether to keep the previous one or change the activity. Marzano's taxonomy describes the following categories:

2.9.1 Knowledge Domain

Knowledge is an important factor in thinking process. All other three systems are failed with little knowledge or no information of the concerned topic. All process of thinking is collapsed without knowledge. So, knowledge is the basic building block of thinking process. Marzano divides knowledge into further three sub categories: information, mental procedures, and physical procedures.

- **Information:** Facts and figures are called information. This information can be presented in the shape of figures, charts, ideas in a logical sequence.
- **Mental procedures:** Mental procedures can be simple or complex. These mental procedures can be simple to complex or complex to simple.
- **Physical procedures:** It includes everything which is involved physically in learning process such as reading, writing, listening and doing.

2.9.2 Cognitive system

Knowledge domain is the first step in cognitive system. People get information through mental process and keep in their memory. The Cognitive System consists of four elements:

- **Knowledge Retrieval:** A man's brain is full of memories. Recollection of information from memory is called knowledge retrieval.

- **Comprehension:** To understand the concept, to differentiate the things, to use the available knowledge to create meaningful information.
- **Analysis:** In cognitive system, to find out the errors, to describe each and every term in detail, learner can use these terms and explain new things.
- **Knowledge Utilization:** The third level is utilization of the available knowledge. It involves decision making process.

2.9.3 Metacognitive system

Thinking about thinking is the base of Metacognitive system. It involves us to use our best abilities to learn and get new information. It involves the learning goals and how knowledge is imparted. Metacognitive system has a superior position among all other system because it controls all other systems. It decides goals; it decides how information will be processed and what information is needed.

2.9.4 Self-System

Self-system plays a key role. It consists of a person's attitude, his beliefs and his emotions. How he feels, how he takes things around him. All these things decide how a person behaves under certain circumstances. How he takes new task and completes it. Motivation also plays a positive role in self-system.

- **Importance:** In every new task, students usually categorize it whether it is important and urgent or not. So, they decide when, where and how to complete that specific task. They do the task first which will take them toward their already set goals.
- **Efficacy:** Students know their strengths and do their best to complete the task in effective way.

- **Emotions:** Emotions play a vital role in learning experiences. Emotions cannot be controlled but lead us toward our goal either in a positive emotional response or in a negative emotional response (Marzano, 2000).

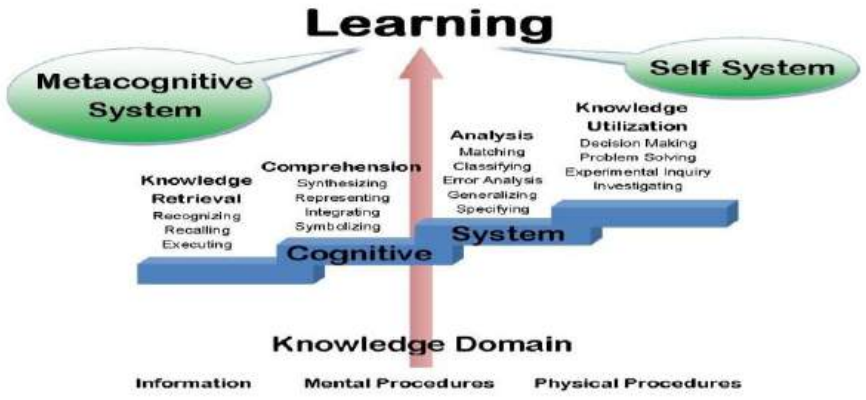

Figure 2.2 Marzano's Taxonomy of Educational Objectives (2000)

2.10 Models of teaching science

With the quick progress in the field of science and technology, the needs of students also change. Their shortcomings need to change the scenario in order to meet the needs of society in the future. Various strategies and methods are developed for different learning styles of students. For this purpose, the researchers recommend methods and models for teaching. Singh (2005) has used joint educational skills in the fundamental science curriculum. It has been investigated that such steps should be implemented for the betterment of the student's future. Shawl (2003) has also developed a natural approach for the development of ecological morals. This model enables the students to enhance their capability and awareness. Akar (2012) has also developed their own model to evaluate students' intelligence. Other researchers concentration on problem-based learning and its long lasting effects. Information is not a goal to be assessed but it should be rather crisis solving. Traditional educational deficits shall be addressed by problem based education. Students should be discouraged from linking to previous knowledge. (Teo & Wong, 2000) the idea presented a

phenomenon. Students can learn science by model which is predetermined. Each model consists of a unique prescription. Some important teaching science models are described below:

2.10.1 Inquiry Training Model

Singh (2005) referred Suchman's Efforts to introduction of the model and make it public. This idea explains that students face puzzles. They develop their intellectual strategies for learning scientific approaches so students can seek the help of innovations. Various surveys showed that an environment of alternative interpretation would be feasible.

2.10.2 Concept Attainment Model

Famous researchers like Jacqueline Goorow, Burner and George Austine designed the model in 1956. The model aimed at exploration of human thinking process and this model originated from research. It is clear that human has the ability to classify the existing things in the world. Consequently, there are three ways that are beneficial for human beings. Firstly, it minimizes the complications of the surroundings and secondly, it provides learners time to find methods and magnified things in this universe and third one is continuous learning (Parveen, 2010).

2.10.3 Carroll's Model

Singh (2005) said that John Carroll was the founder of Carroll's Model. According to him the fundamental idea behind this model is fixed time. There are five parts of this model. These are regarding goals achievement through instructions. He further explained that students having low learning levels require time for study and a higher level of ability. Meanwhile learning eagerness of the students leads to objectives of teaching. Generally, students should understand something. More intelligent students need less time for the achievement of their purpose. Two prominent features of the

model namely teaching standards and learning opportunities in the practical field enable the students to get more results. This process has shown great success. The fourth stage indicates assessment of performance. The teachers evaluate the results. Many tools are used for searching for desired objective. This model is considered to be the major teaching model (Singh, 2005).

2.10.4 Synetics Model

Parveen (2010) was of the view that synetics model is based on the student's creative thinking skills. These skills are utilized in development of creativity. Gordan was busy in industrial organization. He also presented the concept of Synetics for the promotion of creative groups. People got training with these groups, for the solution of issues and development of product. Gordon considers Synetics basic concepts are as follows:

1. Creativity is necessary in daily activities.
2. Creativity should be increased and conveyed through training and it is not a new and strange thing.
3. New ideas and schemes are same in every sphere of life.
4. Nevertheless, creativity is a term that is beyond constructs.

2.10.5 Problem Solving Model

In mounting scientific thinking and theoretical understanding, the problem-solving capability enables the learners to handle problems arising in our setting. It is associated with the scientific reasoning and constructing suitable judgment through resolving scientific issues (Abdullah & Shariff, 2008). The necessary factors of problem solving model is found in experimental psychological work (Akar, 2012). He termed a general problem solving strategy as an initial point. Five stages are counted in

such a category. Bransford and Stein (1984) used the acronym IDEAL to determine five steps:

I- Identify opportunities and problems.

D- Defining objective and representing the issue.

E- Exploration of strategies.

A- Anticipate outcomes and act upon the procedure.

L- Look back to comprehend something.

2.11 Theoretical Framework

Three main theories help to understand the concept of the 5Es instructional model in detail. First is the Theory of Constructivism developed by John Dewey in the 1920s and 1930s, which proposed that learning occurs through experience. Constructivism is a philosophy about learning that suggests that learners build their understanding of new ideas during teaching and learning. Much has been researched and written by many eminent leaders in the fields of learning theory and cognition. Scholars such as Jean Piaget, Eleanor Duckworth, George Hein, and Howard Gardener have explored these ideas in-depth. According to constructivist views, students express their current thinking when they interact with objects, organisms, and substances which equip them to develop a range of experiences on which to base their thinking. The Biological Science Curriculum Study (BSCS), a team whose principal investigator was Roger Bybee developed an instructional model for constructivism, called the 5Es. Each of the E's describes a phase of learning and each phase begins with the letter E's which are: Engage, Explore, Explain, Elaborate and Evaluate.

Second is the Theory of Ego Development, first proposed by Erik Erikson in the 1950s and 1960s, which stated among other things that a child's environment is crucial to his growth and third is Vygotsky's Sociocultural Theory (1986), which stated

that children are drawn into cognitive activities when active participation in the learning is required.

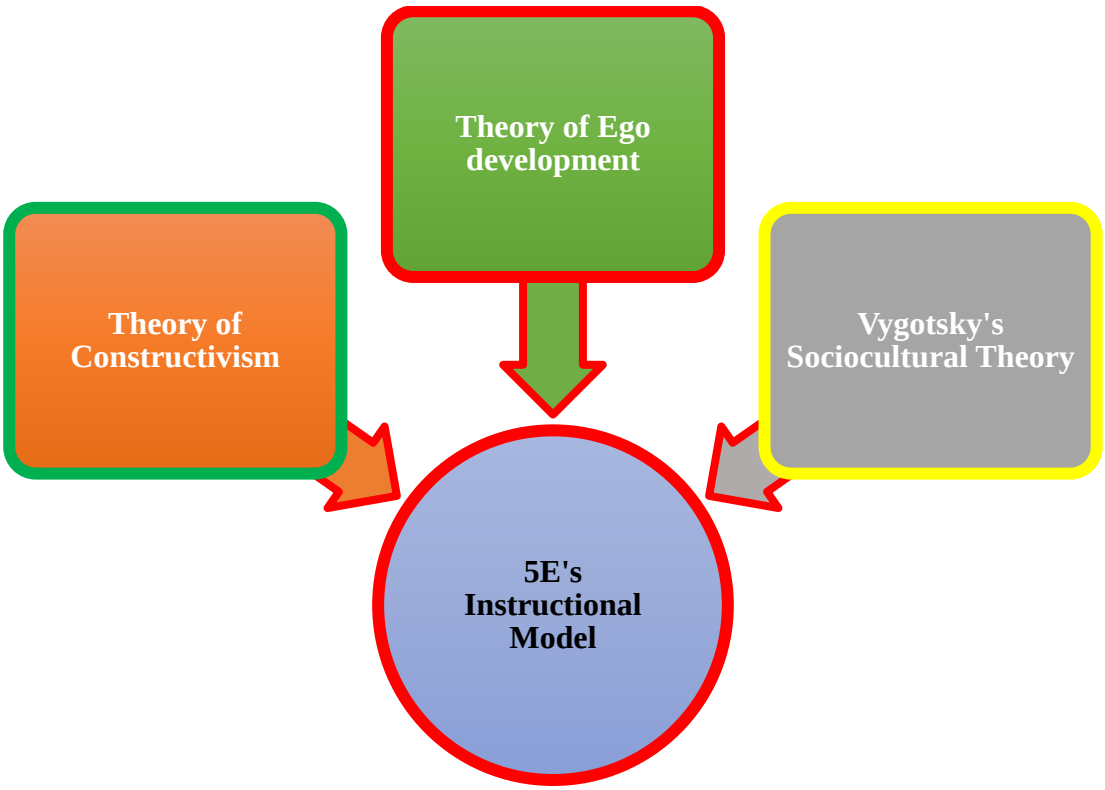

Figure 2.3 Theoretical Framework of 5E's Instructional Model

2.12 Overview of similar studies

5Es instructional model is used in science and related disciplines all over the world but in Pakistan, it is used in few researches. 5Es instructional model is used in science and its relative fields and has shown positive results. In Pakistan, only a few research studies have shown 5Es learning cycle on science subjects. 5Es instructional model applied by Parveen (2011), Javed (2012) and Khalid (2012) in their research studies:

Parveen (2011) conducted a study on 5Es instructional model in science of primary students with hearing impairment it was a study on the basis of experiment

study having pre-test, post-test control develop group used. This study was conducted on grade 8th general science at Hamza Foundation Academy for deaf students. According to findings, 5Es model teaching is more beneficial than conventional teaching for students.

Javed (2012) also tested learning model for science teaching at primary level is effective. This research was based on experiment having pre-test and post-test group design. Students of class 7th in Abbottabad were involved in this process. There were 240 students, 120 girls and 120 boys. Learning model dimensions were used in teaching of experimental and control groups. The result of learning model study followed the experimental group showing excellent performance in post-test by achieving good scores as compared to controlled group.

Khalid (2012) was of the opinion that learning in constructive classroom was better and its efficiency level was higher than conventional learning environment. This group have advantages like high level of satisfaction, active and increased students' participation. Students answer willingly and putting questions to the instructor for clarification of material and problems. So team work and discussions led to introduction of new points. Constructive teaching method was investigated to be far better than conventional method.

Nwagbo & Obiekwe (2010) discussed the concept, effects of learning in the ecological concepts of Biology. The sample was made by 154 SS-2 Biology students. 38 items multiple choice in Biology subject were comprised. The study having half of experiment pre-test and post-test non-equivalent control group, consisted of giving answers to the research questions, deviation was used as of standard type. Ecological concept are elaborated through constructivist instructional method much better than conventional and lecture method.

Ozlem & Jale (2010) investigated the effectiveness of 5Es learning cycle instructions on 11th class students about the achievement of human circulatory system so a test was conducted to assess the achievement of students regarding the topic concerned. There were two teachers from class 6 comprising 60 students of class 11th took part in this study. One class of each teacher was assigned and experimental group were treated with 5Es learning cycle instruction and other class was assigned as control group and treated with traditional instruction. The human circulatory system achievement test was applied two times as pre and post-test to both groups, experiment group performed better.

Acish et al. (2011) described the capability of students guiding materials on students' progress, using the 5Es teaching model. Researcher developed the materials based on the movement and force unit's objectives. There are 60 students, 30 control and 30 experimental. Control group students were given the task to prepare for experiment according to 5Es learning model. They were given experiment booklet, achievement test on movement force issues were applied to the groups in order to determine the differences between two groups. Both should be compared as regards results by using a test in SPSS P Packet Program. Fruitful difference has been shown between the groups.

Bunkure (2012) explored the impacts of CIS on the academic achievement retention attitude to Physics among science students at secondary level in Kano State used 5Es learning model pre-test and post-test experimental research. A simple technique was used and selection of 4 schools out of 7 science secondary schools in Kano State. 160 out of 1559 SS-II Physics students were selected for this study. PAT and PAQ were used to collect data. The credibility of Physics achievement test was calculated to be .86. Six null hypotheses were tested at $P<.05$ level significance using

t-test (ANOVA) and Mann Whitney U test statistics. The following findings were collected (i) students disclosed to constructivists instructional strategy achieved, retained and learnt concept of Physics and more innovative method leads to traditional mode of teaching. (ii) no major difference in students' achievement with reference to gender. (iii) the strategy feasible for students of varied ability levels. Keeping in view these findings many recommendations were made for the enhancement of teachings Physics in secondary schools. Physics teachers should use 5Es constructivists instructional strategy in the teaching method of Physics seems to be high capabilities for improving understanding achievement and retention the part of the learners.

Shittu (2013) held a study on impacts of guided inquiry strategy using 5Es learning cycle on learning outcomes of low obtaining secondary schools Physics students in Kaduna Metropoils 1,714 SS-2 population students and subjects were made experimental and control group. This group was consisted of pre-test and post-test as the structure for study. He selected 91 low achieving students as the sample of study. Inquiry method was adopted for teaching to experimental group while lecture method was adopted for control group for six weeks. After analyzing the data by using *t*-test and Wilcoxon statistics resulted low achieving students use inquiry method than lecture method in Physics. The attitude of experimental group had already improved. It has been revealed that guided inquiry favoured both male and female low achieving Physics students.

Gloria (2014) also investigated the impact of 5Es constructivist's instructional model on students' achievement and attitude to Chemistry. This study was carried out in Nsukka Local Government Area of Enugu State. Meaningful technique was used in selecting four secondary schools out of 30 secondary schools in Nsukka LGA. Two schools from the city and two from the rural area. These four schools having common

qualities, were selected. These qualities were science lab, qualified Chemistry teachers and two streams of SS I class each urban, rural and educational schools were opted for variability of gender and location. Two instruments, namely CAT and SAS were used for data collection. This study was guided by six research questions and six hypotheses. The data were analyzed and hypotheses and standard deviation were tested by using ANCOVA. Other result disclosed that 5Es CI approach was superior to CIM lecture in facilitating students' attitude to Chemistry than the traditional way of teaching. No such major difference in the means score of male and female students seen. Male students slightly better than female students with regard to their performance. The study showed that the urban students have good approach in the Chemistry as compared to the students of rural areas.

Ngorogi et al. (2014) found the impacts of inquiry based teaching approach using 5Es learning cycle on performance and motivation of secondary school students in Physics in Nyeri country, Kenya. In this connection random sampling technique was used to select four boys and girls each country secondary schools in Nyeri. These groups were assigned to *t*-test and control groups by simple random sampling technique. Each group had one boy and one girl country secondary schools. Each school has one from two classes for the study having 370 students. All students of all groups were taught the same Physics but the experimental groups were taught using IBT approach while the control groups were taught Regular Teaching Method such as lecture method and teacher demonstrations. The experimental groups l and control group II were pretested prior to implementation of the IBT. All the four groups were post tested using the students Physics achievement test. This showed that IBT approach resulted into higher students' scores in achievement in Physics.

Ibrahim (2015) researched on the effects of 5Es teaching cycle on Attitude, Retention and performance in Genetics among Pre-NCE Biology students with different capabilities. North West Zone, Nigeria, Federal college of education Zaria rendered service as experimental group while Federal College of Education Katsina's role was as the controlled group. 55 students (38 males and 17 females) were selected from each college to study by Central Limit Theory that in nature thirty or more subjects as a large sample for this nature. Both groups all of three type tests were for the study. Approximately total 110 students took part in this programme. Equality in subjects for each group was maintained so that fair play with regards to subjects is retained. 5Es learning cycle is for removal of difference in their mental and ability level. Subjects of both the groups were relocated to subgroups in accordance to their capabilities by satisfying sampling technique after the pre-test. These grouping were established by categorizing the subject into high and low ability group where different range of scores were kept in view like 60-100 comprised high abilities 40-59 average and 0-39 low ability subject. Both the groups were exposed to respected method like 5Es teaching cycle and lecture method. To examine the impacts of 5Es learning cycle the post-test was given. There was gap of two weeks between the pre-test and the post-test so that ability of the subjects maybe determined. The results of the study indicated that pre-NCE Biology students of 5Es cycle in the teaching and learning of genetics concepts in all the abilities level had higher means performance scores and also retained more than those in the controlled group to lecture method. It has been observed that male and female performed equally well without difference in their retention abilities. The attitude of the experimental groups improved vehemently in all three ability level.

Magak (2016) also searched the effects of constructivists instructional method on learner achievement in Biology in secondary schools in Homabay County, Kenya

constructive instruction has independent variable while learners' achievement in Biology has dependent variable. This enables learners to incline his / her attitude to the constructivist's instructional method. Each group has been assigned different method of instruction for showing results in a progressive manner. Targeted strength was 61,115 students who were enrolled in 196 secondary schools of Homabay County. The study showed various sampling where mean score in biology ranging from 4.5 to 6.4 in year 2010 KCSE in 57 schools out of 196 schools in the county. Boys, girls and mixed schools were formed into groups categorizing of 57 schools. Four boys, four girls and four mixed schools were selected for taking part in the study. Only one from three class was selected from the schools where two or more for participating in the study. Total 447 students were participants who were assigned in to two groups. Conclusions indicates that constructivist instruction is more impressive in learning Biology compared to conventional instruction. Girls learn better than boys when taught through constructivist instruction. Girls perform better than boys. It has also been observed that girls have constructive approach having more positive approach and behaviour as compared to boys.

Belapurkar (2017) conducted a study on the effectiveness of 5Es learning model on academic achievement of science students. It is clear that the present research is our experimental research testing teaching effectiveness for science 8th class students. It includes survey made by a science teacher developing a progress in 5Es instructional model. According to surveys and opinions of teachers, science required active participation of students for better results and understanding in a better way. Students focus is essential so that they comprehend with full satisfaction. Similarly, in actual practice this is not occurring in classrooms in account of many reasons. 5Es

instructional teaching model used for 8th standard students for science teaching was found effective to the extent of student.

Sen & Oskay (2017) studied the content achievement of comments over Chemistry. This was quasi experimental based research. A total 34 (8 males and 26 females) under graduates in Turkey willingly took participation in this study. The 5Es inquiry learning activities were applied to lecture-based traditional activities applied to the control group. The same instructional materials were used in both groups, and the same books were used. The Chemical Equilibrium Concept Test (CECT) and Attitude toward the Subject of Chemistry Inventory (ASCI) were applied to both groups as pre-test and post-test. It has come to the light that 5Es inquiry learning activities have deep effects to improve the achievement in Chemical balance compared to lecture based traditional activities.

Tonseenon (2017) investigated the effectiveness of 5Es learning cycle model on achievement and science of science students' teachers. The main purpose of this study is to compare the science achievement and science design ability of science students' teachers before and after learning through the 5Es learning cycle model. 4th year science students were sample and teachers taught 38 students of 2nd semester 2016, Udon Thani Raja Bhat University, Thailand. The materials were used as research instrument were the lesson plan of 5Es learning cycle model of Atmosphere and Weather. The science achievement test and science lesson ability test. One group pre-pest, post-test design carried out the research. The ultimate result of this study were as follows: (i) The science students' teachers taught with the help of 5Es learning cycle model have achievement in science pre-test scoring 34.66 (57.76 %) after learning their post-test mean score 49.68 (82.81%). (ii) The science lesson design ability pre-test

means score 12.08 (50.33%) after learning their post-test mean score is 20.08 (83.66%). The results show each of the post-test means was higher than 80 %.

Cheta & Chidinma (2018) found the result of two approaches mastery learning approach and constructive based learning approach on secondary school students in biology. The academic session 2016 / 2017 of the senior secondary school biology students of Hallmark Academy Secondary School, Omoku, Rivers State. The sample size was made by 58 students into two streams. Both streams have 28 and 30 students respectively. Stream A students were taught mastery learning approach and stream B students were taught constructivist based learning approach. It has been disclosed that students of stream A had higher academic achievement than that of stream B.

Umahaba (2018) found the impact of 5Es learning model on performance in chemical equal concept among Secondary schools' students of Katsina Metropolis and Nigeria. Both groups have own importance but the experimental group relate the concept of balancing chemical equation while other group was taught using lecture method. As a result, experimental group's students' performance was much better than that in control group. As regards gender treatment, it was friendly based atmosphere.

Resultantly studies were continued in various fields of science at elementary and secondary school. Mostly, subject of biology was given importance at secondary level and science at primary level. Chemistry faces shortage of studies. It means that lesser studies were there on chemistry. The 5Es instructional model does not opt in Pakistan at the Federal level at the secondary level in the teaching of Chemistry. This gap was filled by this experimental study.

2.13 **Summary of the literature review**

The review of literature was allied to a combination of various domains. First of all, constructivism theory and constructivist instructional methods were discussed in

detail, how knowledge is built from the existing knowledge in a proper and useful manner. The theory was based on obtained knowledge by the learner through proper instruction. Constructive minds are deeply rooted in psychology and philosophy. The constructivist methods of instruction permit learners to be close to the learning environment by taking part in the creation of knowledge. The second domain related to the 5Es instructional model, it has been confirmed that chemistry is a difficult subject consisting of abstract fundamental concepts. Misconception and complication are there in chemistry which needs skills if chemistry is based on a constructive model in a pure environment, then it may be the best and effective. 5Es instructional model is an inquiry-based approach, helpful in science particularly in chemistry. 5Es has interconnected phases of learning and constructing individual knowledge through old and new experiences. It can also be helpful for solid concepts and skills and education of concerned misconceptions. The five stages of the 5Es instructional model are, Engage, Explore, Explain, Elaborate and Evaluate. These stages are interconnected with each other and helpful in lesson planning and instructions. The third domain is related to personalize learning in which teachers have tried to deal individual necessities of the students by including their necessities in instruction. Personalized learning can be seen in school vide combining activities of ideas across grades and subject areas. The 5Es model promotes personalized learning of the students.

In the fourth domain traditional learning model was discussed in detail with its main components. Traditional learning is a sort of programmed learning that is free from comprehension. Traditional learning model is used by the majority of teachers for immediate memorization. In the fifth domain Bloom's Taxonomy of Educational Objectives and Marzano's Taxonomy were explained in detail with their special elements. These taxonomies helped develop items. The sixth domain related to the other

prominent models of teaching science; (Inquiry training model, Inquiry attainment model, Corroll's model, Synetics model, Problem-solving model), main characteristics and major elements were discussed there. The seventh domain related to the theoretical framework of the study, the 5Es instructional model is rooted in three theories which are, the theory of constructivism, the theory of ego development and Vygotsky's sociocultural theory. Lastly, an overview of similar studies was given in which 5Es instructional models were used. To fill the required gap from the existing studies, the current research study was conducted to find the effects of 5E's instructional model on academic achievement in 10^{th} grade Chemistry.

CHAPTER 3
RESEARCH METHODOLOGY

The study was carried out to explore the "Effects of 5E's Instructional Model on Academic Achievement in 10th grade Chemistry". The following procedure was adopted for the study.

3.1 Research Design

This study was true experimental. In which a pre-test, post-test equivalent group design was employed by the researcher. It consisted of two groups; the experimental and the control, which were equated based on marks achieved by the students in the pre-test from grade 10th Chemistry, published by the National Book Foundation, Federal Textbook Board, Islamabad (2022). The experimental group received a treatment that was taught through 5E's Instructional Model, while the control group was taught through the Traditional Teaching Method. At the end of the experimental period, post-test and retention test were administered to both groups. The symbolic representation of the research design was:

Table 3.1
Schematic Representation of the Design of the study

RE	O1	T	O2	DXE (O2-O1)	D (DXE-DXC)
RC	O3	-	O4	DXC (O4-O3)	

(Gay, 2012)

Here:

R stands for randomly selected sample

E for Experimental Group

C for Control Group

O1 and O3 for pre-test observations

O2 and O4 for post-test observations

T for Treatment

DXE for Academic Achievement of Experimental Group

DXC for Academic Achievement of Control Group &

D stands for Difference in Academic Achievement of Experimental and Control Group

3.2 Population

The population has been defined in such a way that it is the target group that belongs to the interest of the researcher and the result of the research study can be generalized. Population by its characteristics needs to be accessible or available in terms of time and cost. Thus the population is a realistic choice, not an idealistic one (Gay et al., 2012). In this study, the target population consisted of all 10^{th} grade boys' science students enrolled in 77 Boys Secondary Schools which were administered by the Federal Directorate of Education, Islamabad. The target population could not be reached. Therefore, the researcher defined the available population of this study.

3.3 Sample and Sampling Technique

A sample is a small group of individuals, things or events representing the characteristics of the large group from which the sample is drawn (Gay et al., 2012). Only one school, Islamabad Model School for Boys (vi-x), Noor Pur Shahan was randomly selected for the study. All the students of 10^{th} grade (80 Boys) studying the subject of Chemistry at that school were selected as sample of the study. The class was divided into equal groups experimental and control groups. Each group consisted of 40 students. The students were divided based on pre-test scores. One served as the control group whereas the other as the experimental group.

Table 3.2
Sample of the Study

Group Type	Chemistry Students (10^{th} Grade) (Boys)
Experimental	40
Control	40
Total	80

3.4 Selection of Units from Chemistry Textbook for Treatment

The following three units were selected for intervention after meeting with the concerned teachers of the experimental school, according to the syllabus they had already covered and students faced the problems in specific units from 10^{th} grade chemistry textbook published by the National Book Foundation, Federal Textbook Board, Islamabad (2022).

- Acids, Bases and Salts
- The Atmosphere
- Water

The detail of the above-mentioned units is described below:

Unit-10 "Acids, Bases and Salts" includes the sub-topics, Introduction of acids, bases and salts, Concepts of acids and bases, Arrhenius concept of acids and bases, The Bronsted-Lowry concept of acids and bases, Lewis concept of acids and bases, Self-Ionization of water, The pH scale, Salts and their major types and their importance in our life. Unit-14 "Atmosphere" includes the sub-topics, Introduction of atmosphere, Components of atmosphere, Layers of atmosphere, Air pollutants, Sources of air pollution, Global warming, Acid rain and its effects, Ozone depletion and its effects. Unit-15 "Water" includes the sub-topics, Introduction of water, Properties of water, Importance of water in our daily life, Composition of water, Concept of water as a

universal solvent, Concept of soft and hard water, Types of the hardness of water, Methods of removing temporary hardness, Methods of removing permanent hardness, Disadvantages of hardness in water, Water pollution, Waterborne diseases.

3.5 Development and Validation of Lesson Plans

The researcher developed a total 48 lesson plans, of which 24 lesson plans were related to the experimental group and 24 lesson plans for the control group. All the lesson plans were developed from the sub-topics of the already selected three units of 10th grade Chemistry. Same sub-topics were selected for teaching both groups. Eight lesson plans were developed for both the groups from each unit. The lesson plans of the experimental group (Appendix 1) were based on 5E's instructional model, which consisted on five phases or steps, (Engage, Explore, Explain, Elaborate and evaluate). Whereas, the lesson plans of the control group (Appendix 2) were based on the traditional teaching method which consisted on the steps introduction, presentation (description), evaluation and homework. The lesson plans of the experimental and control groups were validated through the opinions of senior Chemistry teachers and experts. The researcher had taught classes for both the experimental and control groups according to the developed lesson plans for each group.

3.5.1 Lesson plans of experimental group

The researcher developed 24 lesson plans from 5E's instructional model for the experimental group. The lesson plans of the experimental group were based on 5E's instructional model, which consisted of five phases or stages, (Engage, Explore, Explain, Elaborate and evaluate). This model is based on the constructivism theory which promoted critical thinking, curiosity and inquiry based learning among the learners. The 5E's Instructional Model phases explained are below:

i. Engagement

The researcher involved the students in various activities which assessed the students' prior knowledge gained and imparted such ideas that provoked interest in gaining further knowledge. During this phase, he played short videos and also used models and charts. This created a link between past and present learning among students. It brought optimism of interest in the material that was taught.

ii. Exploration

The researcher provided students with a framework of activities to analyse existing concepts (e.g., misunderstandings), methods, and skills and facilitated strategy change. It encouraged sharing and further discovery, which promoted students' natural curiosity. Students were able to ask questions and helped them find answers on their own. Students performed laboratory activities that helped them to use existing knowledge to develop new ideas, explore problems and possibilities, and design and conduct an initial investigation.

iii. Explanation

The researcher used this technique as a tool for students' reflections on specific aspects of their involvement and investigation, which provided the opportunity to demonstrate their understanding, skills or attitudes. It emphasized the students' understanding. The researcher also taught a concept, process, or skill directly in this stage. Explanations from the researcher or the class deepened their understanding, which was important at this stage.

iv. Elaboration

The researcher involved students in explaining and describing ideas with details. It involved making connections among ideas he tried to teach and connected

the material to students' experiences, and memories with daily life. This, enabled students to apply what they had learned about the topic through additional activities.

v. Evaluation

Evaluation is an ongoing process, and due to that it is continued in each phase of the 5E's instructional model. The researcher encouraged students to assess their understanding and abilities, it also focussed on rating, and assessing the teaching effectiveness and student progress.

3.5.2 Instructional strategies of experimental group

The researcher considered a 5E's Instructional Model for the experimental group, which was developed by Roger Bybee and their team. This model is based on the constructivism theory. The 5E's instructional model was not used in teaching Chemistry in government secondary-level schools of Islamabad. The researcher delivered 24 lesson plans to the experimental group. The following strategies in 5E's instructional model were used by the researcher for the experimental group.

i. To encourage constructivist and inquiry-based learning

ii. To promote a student-centered learning environment during lecture

iii. Offer students to actively participate during lecture

iv. Acts as a consultant for students

v. Encourages student-to-student interaction

vi. Encourages students to explain concepts and definitions in their own words

vii. Provides time for students to compare their ideas with others and if desired revise their ideas

viii. Encourages students to apply the concepts and skills in new situations

ix. Ask questions that help students draw reasonable conclusions from evidence and data

x. Uses a variety of assessments to gather evidence of student understanding

xi. Provides opportunities for students to assess their progress

xii. To transfer the subject material through group discussion and activities

xiii. Students provide an opportunity to work in groups

xiv. Individual differences among students kept in mind during the lecture

3.5.3 Lesson plans of control group

The researcher developed 24 lesson plans from the traditional teaching method for the control group. The lesson plans of the control group were based on the traditional teaching method, which consisted on the steps introduction, presentation (description), evaluation and homework. That method is based on rote memorization which promotes factual information in the learners. The traditional teaching method steps are explained below:

i. Introduction

The researcher provided a feasible environment to the students for the purpose of learning. He asked questions from the students based on previous knowledge.

ii. Presentation (Description)

This step was used for the provision of explanations about related topics. For a better understanding question and answer technique was used and related model and examples were put forward if needed.

iii. Evaluation

During this step researcher evaluated the students' learning by asking some questions from the delivered lecture, in this way he also assessed his teaching.

iv. Homework

After completing all the steps, the researcher gave the home task to students which were related to the delivered lecture.

3.5.4 Instructional strategies of control group

The researcher considered a traditional teaching method for the control group. Most teachers used the traditional teaching method in teaching Chemistry in government secondary-level schools of Islamabad. Hence, the traditional learning method was selected for the control group. The researcher delivered 24 lesson plans to the control group. The following strategies in the traditional learning method were used by the researcher for the control group.

i. To promote rote learning

ii. Subject matter delivered by traditional learning method with the help of whiteboard

iii. There were poor communicational activities among the students' groups

iv. Only textbook was used for teaching and judging the students' outcomes and for home tasks.

v. Students worked individually when any work was assigned to them, no group engagement.

vi. Students were forced for proper maintenance and completion of notebooks

vii. The students were physically passive and mentally active

viii. The teacher-centred approach was applied during the lecture

ix. The related Chemistry topics were clarified by the researcher with the help of the textbook reading, oral explanation of the main concept even diagrams and chemical reactions explained orally or with the help of whiteboard.

x. All students were treated equally during the lecture; students' individual differences were fully ignored.

xi. The researcher's attitude was harsh during the lecture due to a lack of student's interest in learning, irrelevant questioning and non-serious behaviour from students.

3.6 Research Instruments

The researcher used the following instruments for data collection.

3.6.1 Pre-test

A pre-test prepared from the selected units in the 10^{th} grade Chemistry textbook was administered to categorize the sample of study into experimental and control groups before giving treatment. The scores obtained by the students in the pre-test were used as the basis for the experimental and control groups' formulation. Based on pre-test scores, the sample of the study was categorized into two equivalent groups (experimental and control) (Appendix 6 & 7). The pre-test was developed under the supervision of a supervisor and co-supervisor. This research instrument was validated by the subject specialists, academicians and assessment experts (Appendix 8). The pre-test consisted of 100 multiple choice questions (MCQs) containing 100 marks. (Appendix 3)

3.6.2 Post-test

After the completion of the experiment (eight weeks' treatment), the post-test (equivalent form of pre-test items but with different sequential order of the stems, correct answer and distractors) was administered to both groups. In fact, this test was the true copy of the pre-test as far as the nature and type of test items were concerned, but here the order and sequence of test items were changed. (Appendix 4)

3.6.3 Retention-test

To measure the retention of students' knowledge, a retention test was administered to both groups after four weeks of the experiment. This was a true copy of the post-test. (Appendix 5)

3.6.4 Construction of test items

For the purpose of pre-test multiple choice questions (MCQs) construction, the researcher selected three units from 10th grade Chemistry textbook published by the National Book Foundation, Federal Textbook Board, Islamabad (2022). The test was of 100 marks and it consisted of 100 multiple choice test items. The time duration for the test was two hours. The 33 MCQs from Unit-10 (Acids, Bases and Salts), the 33 MCQs from Unit-14 (Atmosphere), and the 34 MCQs from Unit-15 (Water) were developed.

3.6.5 Validity of the instrument

According to Gay, et al (2012) "Validity refers to the degree to which a test measures what it is supposed to measure. When we test, we test for a purpose, and our measurement tools must help us achieve that purpose". All the test items were improved by the experts' opinion because a good instrument must not only be reliable but also be valid.

3.6.6 Reliability of instrument

"Reliability is the degree to which a test consistently measures whatever it is measuring" (Gay, et al., 2012). Split-half method was applied to test the reliability of the multiple-choice test items. For the purpose of split-half method pre-test was applied for pilot testing. In this connection, 25 students of grade 10th were selected randomly from another school. This method is used to test the correlation among the even and odd number of test items in the instrument for its reliability through coefficient alpha.

So, the reliability coefficient alpha reflects that the research instrument was reliable because the coefficient alpha of test items used for pilot testing in government boys' high school remained .79.

3.6.7 Marking of test items

The researcher opted for the international standard for marking multiple-choice test items. According to that one mark is allocated to each correct multiple-choice test item. To maintain standard errors like cutting, overwriting and picking of more than one option were not allocated any marks. All multiple test items were marked by the researcher according to the developed marking key.

3.7 Variables

The variables which were used in the current study are described below:

3.7.1 Independent variable

The treatment variables were considered as independent variables.

Treatment variable

The teaching methods were used as treatment variables in the current study. The treatment variables were comprised of 5E's instructional model and traditional teaching method.

3.7.2 Dependent variable

The academic achievement of students was considered as dependent variable.

3.7.3 Extraneous variables

In the current study, different types of situational variables were used e.g., time, duration of treatment, age of students, teacher, subject to being taught, use of teaching aids, condition of teaching, sample size, the language of teaching, selection of the sample, equating of time, equating the groups through pretesting and through equal environment etc.

3.8 Explanation of the experiment

The experiment was carried out for a period of eight weeks in Islamabad Model School for Boys (vi-x), Noor Pur Shahan, Islamabad which was administered by the Federal Directorate of Education, Islamabad. The researcher as a science teacher and having an experience of ten years of Chemistry teaching himself taught the experimental and control groups. The researcher took a total 48 classes in selected school, 24 each for experimental and control groups, three days a week, on Monday, Tuesday and Wednesday. Two periods each day on already selected days, one period for the experimental group and one for the control group. The duration of each period for teaching experimental and control groups was of 40 minutes. The researcher followed the timetable of the selected school for the conduction of the experiment. The experimental group was given treatment according to 5E's instructional model by giving them a constructive atmosphere in their regular class. The control group was taught through the traditional teaching method in their regular class. After the passage of eight weeks' the post-test was applied for both groups and the data were collected. To assess the retention of the content in both groups' retention test was applied after four weeks of post-test. For the conduction of the experimental research in Islamabad Model School for Boys (vi-x), Noor Pur Shahan, Islamabad, the researcher took a permission letter from the Federal Directorate of Education (FDE), Islamabad. (Appendix 9)

A further explanation of the experiment is described below:

3.8.1 Duration of the experiment

The current experiment was performed by the researcher from August 03 to September 29, 2022. The researcher followed the timetable of the selected school (Islamabad Model School for Boys (vi-x), Noor Pur Shahan, Islamabad). Two periods

of 40 minutes per day were specified for the intervention of experimental and control groups. The total period of the experiment continued for eight weeks (Monday, Tuesday and Wednesday per week).

3.8.2 Equal educational opportunities

The experimental and control groups were provided the equivalent educational opportunities in the current experiment by the researcher. Therefore, to fulfil the requirements of the experiment, the researcher took the following steps:

i. Equal time duration (40 minutes) of teaching to each group

ii. Same units and sub-topics selected for both groups to teach

iii. Same number of lesson plans for both groups

iv. Same time (120 minutes), allocated for both groups during pre-test, post-test and retention-test.

3.9 Execution of Experiment

The following steps were taken by the researcher to execute the experiment.

3.9.1 Ethical consideration

The researcher signed the permission forms, from the principal of the experimental school and also from the parents of the grade 10th students before the start of the experiment, which were selected for the experiment. For the conduction of the experimental research in Islamabad Model School for Boys (vi-x), Noor Pur Shahan, Islamabad, the researcher already took a permission letter from the Federal Directorate of Education (FDE), Islamabad. The Students of the experimental research were properly updated about the experiment. The main purpose of the study was to improve the concepts of Chemistry in a logical way and also develop a sense of inquiry-based learning among the students by using 5E's instructional model. The researcher

guaranteed the principal of the experimental school about the confidentiality of the data which were obtained from the students only for research purpose.

3.9.2 Administration of pre-test

Before starting the treatment, a pre-test was held on August 03, 2022. The scores collected from the pre-test were used to assess the academic ability of students in chemistry.

3.9.3 Teaching-learning sessions

Teaching-learning sessions were conducted from August 08 to September 28, 2022. The intervention of a total 48 lesson plans was implemented with the help of 5E's instructional model and traditional teaching method for the experimental and control groups respectively. The experimental period was comprised of eight weeks.

3.10 Variables' control in the study

This experiment was held in Islamabad Model School for Boys (vi-x), Noor Pur Shahan, Islamabad. The following steps were taken by the researcher to minimize the effect of internal and external threats.

3.10.1 Internal validity of the experiment

The researcher took the following steps to control the internal threats of the experiment.

i. **History**: History is a threat that occurs when participants' responses change due to unexpected events during the experimentation process. To control this threat, the study was conducted under well-planned and controlled conditions. Moreover, no such case was observed during the study that may affect the students' achievement. Hence, this threat was controlled.

ii. **Testing**: Another threat is testing that occurs if the students' results in their post-test are improved due to pre-test taken from the same group of members. To overcome this threat time of two months were given between the pre-test

and the post-test, which was enough to forget the test items in the pre-test. Furthermore, this threat was also reduced by minor changes in the sequence and order of the post-test. A retention test was also conducted after four weeks of post-test. Therefore, this threat was also controlled logically.

iii. **Instrumentation:** The pre-test was validated with the help of experts' opinion and its reliability was checked through pilot testing before administering it on the experimental and control groups to avoid this threat. Therefore, this threat was also controlled.

iv. **Maturation:** This threat occurs if the results of the post-test are better not due to the treatment but due to the time period between the pre-test and post-test. Therefore, to control this issue time duration for the experiment consisted of only eight weeks; which was not sufficient to develop the students to improve their post-test. Hence, this threat was also controlled.

v. **Implementation:** The experimental group and control group were treated with 5E's instructional model and traditional teaching method respectively. To control this threat, the researcher taught both groups himself. Therefore, this threat was also controlled in a logical manner.

vi. **Location**: The meaning of this threat is having dissimilar results due to the subject being treated at different locations. One school was selected and the selected students belong to the same locality. Furthermore, experimental and control groups were treated in their regular classrooms. Therefore, this threat was also controlled.

vii. **Mortality:** The experimental study was limited to only eight weeks which is not a long duration. Due to the support and management of the school and also the attentiveness of the selected students made it possible for no student

remained absent throughout the experimental study. Hence, this threat was also controlled.

3.10.2 External validity of the experiment

The researcher took the following steps to control the external threats of the experiment.

i. **Interference of multiple treatments:** There is a possibility of taking extra tuition classes as an extra treatment by the subjects instead of the researcher or subjects already involved in any related research study which may distort the actual results of the experiment. The public school teachers in the Islamabad were not aware of the inquiry-based 5E's instructional model, so there was no risk of treatment being affected. In addition, the researcher applied a similar treatment in both groups (experimental and control).

ii. **Specificity of variables:** All technical steps have been taken to prevent external threats. Lesson plans have been verified; the pre-test was pilot-tested and randomly administered. Because of these specifics, he tried to avoid this threat. There was no gap between the end of the experiment and the post-test. All criteria of the experiment were well defined, such as pre-test, post-test, retention test application of 5E's instructions model through inquiry-based teaching method and duration of the intervention.

iii. **Experimenter Effects:** The awareness of the 5E's instructional model of inquiry-based learning is not present in our education system and our school teachers were not aware of this model. It could remain a gap in training and implementation if school teachers were trained in the 5E's model to facilitate the teaching of the experimental group. The researcher studied this model for about two years and gained a deep understanding of this model through respected supervisor, literature and interactions with critical thinking experts.

To avoid any gap in the experiment, the researcher planned to teach both groups himself by using the 5E's instructional model and traditional teaching method. In addition, various variables were controlled by comparing their effects in experimental and control groups, such as time and place of intervention, lesson length, number of lesson plans, teaching material, students with mixed abilities, and timing of pre-test and post-test.

3.11 Conduction of post-test.

After the completion of treatment, the post-test was managed to the next day on September 29, 2022. Furthermore, the achievement scores of all the students were calculated by subtracting the pre-test scores from post-test scores.

3.12 Retention test

The retention test was managed after the passage of four weeks from the post-test on October 31, 2022. To assess how much the students, retain the concepts, the test was administered for both the groups experimental and control.

3.13 Data Analysis

After scoring the responses of students on pre-test, post-test and retention test SPSS, version-22 (Statistical Package for the Social Sciences) was used. After collecting data from the students, the data were analysed. The descriptive analysis was used to calculate the measures of central tendency (mean) and measures of dispersion (Standard Deviation). The researcher applied a dependent *t*-test to compare the achievement of students of the same group in the pre-test and post-test. Another inferential statistic test was used called the independent sample *t*-test, which is a statistical test to compare the achievements of experimental and control groups and to determine the significant difference in both groups. Pearson correlation coefficient (*r*) was also used to find out the strength of the relationship between the groups.

CHAPTER 4

DATA ANALYSIS AND INTERPRETTION

The current experimental study was conducted to find out the "Effects of 5E's Instructional Model on Academic Achievement in 10th Grade Chemistry." This chapter deals with data analysis and interpretation. This experimental study was performed at one government secondary school in Islamabad. The researcher collected the data from the students with the help of pre-test, post-test and retention test. After collection data were entered in the Statistical Package for Social Sciences (SPSS Version-22), for descriptive and inferential analysis. The descriptive analysis was used to calculate the measures of central tendency (mean) and measures of dispersion (Standard Deviation). In addition, inferential analysis was also applied to the data to compare the academic achievement (scores) of students within the same group and also between the different groups, a *t*-test was used for that purpose. A significance level (.05) was used when comparing groups to accept or reject the hypotheses. SPSS Version-22 was used for this purpose.

Analyses and interpretation of data were described as follows:

4.1 Comparison of Pre-Test Scores of Experimental and Control Groups before Intervention

Data was obtained from the pre-test of the experimental and control groups before the intervention. Data were analysed to examine the pre-intervention knowledge of the sample in 10th grade Chemistry.

Table 4.1

Experimental and Control Groups Pre-Test Mean (Group Statistics)

Group	*N*	*M*	*SD*	*SEM*
Experimental	40	35.7750	9.55547	1.51085
Control	40	35.9000	9.41303	1.48833

Note. M=mean; *SD*=standard deviation; *SEM*= standard error mean

Table 4.1, shows that there were equal number of students in the control and experimental groups who were tested before start of experiment. The mean score of the experimental group was 35.78 and the mean score of the control group was 35.90. The standard deviation of the experimental and the control groups were 9.56 and 9.41 respectively. Moreover, the standard error mean of the experimental and the control groups were 1.51 and 1.49 respectively. The averages of the results of the two groups show that there was no significant difference in the mean scores of the experimental group and the control group. Therefore, the null hypothesis, "there is no significant difference between the mean pre-test scores of students' to be taught Chemistry with 5E's instructional model and with traditional teaching method," was accepted.

Table 4.2

Experimental and Control Groups Pre-Test Mean (Independent Samples Test)

	Levene's test		*t*-test for equality of means						
Group	*F*	*Sig.*	*T*	*Df*	*Sig.(2-tailed)*	*MD*	*SED*	*95%CI*	
								LL	*UL*
Scores	0.16	.90	0.059	78	.95	-.13	2.12	-.4.3	4.09

Note. MD=mean difference; *SED*=standard error difference; *CI*=confidence interval; *LL*=lower limit; *UL*=upper limit

According to table 4.2 that the mean difference in pre-test of experimental group and control group before the treatment was -0.13 and the standard error difference was 2.12. The *t* value was 0.059 and the significance level was .95 which is more than .05. It was

interpreted that there was no significant difference in the scores of control group and experimental group before the intervention.

4.2 Academic Achievement of Experimental Group

Table 4.3
Experimental Group Pre-Test Post-Test Mean (Paired Samples Statistics)

Group (Pair)	*N*	*M*	*SD*	*SEM*
Pre-Experiment	40	35.7750	9.55547	1.51085
Post-Experiment	40	65.5000	5.76906	0.91217

Table 4.3 indicates that there were 40 students in the experimental group who were tested before and after the experimentation. The pre-test mean scores of the experimental group was 35.78 and the mean scores in post-test of the same group after treatment was 65.50. The standard deviation of the pre-experimental and the post-experimental groups were 9.56 and 5.77 respectively. Moreover, the standard error mean of the pre-experimental and the post-experimental groups were 1.51 and 0.91 respectively.

The difference in the mean scores (29.73) indicate that there was big improvement in the students' academic achievement before and after the experimentation. The experimental group was treated with the 5E's instructional model.

Table 4.4
*Experimental Group Pre-Test Post-Test Correlation (*Paired Samples Correlations)

Group (Pair)	*N*	Correlation(*r*)	*Sig*.
Pre-Experiment & Post-Experiment	40	.566	.001

Table 4.4 indicates the correlation between pre-test and post-test in the experimental group. The correlation coefficient (*r*) value between pre-test and post-test was .57 which shows a moderate positive association between them. Which indicating an

increase in student academic achievement from the pre-test to the post test. In addition, the significance level is .001, which is less than the alpha value. In this context, a significant value that is less than the alpha value (.05) indicates a significant difference in the academic performance of the experiment group students before and after the treatment.

Table 4.5
Experimental Group Pre-Test, Post-Test Comparison t Test (Paired Samples Test)

Group (Pair)	*M*	*SD*	*SEM*	*95% CI*		*t*	*df*	*Sig.(2-tailed*
				L L	*UL*			
PreE & PostE	29.73	7.89	1.25	-32.25	-27.20	-23.84	39	.001

Note. M=mean; *SD*=standard deviation; *SEM*=standard error mean; *CI*=confidence interval; *LL*= lower limit; *UL*=upper limit

Table 4.5 shows that mean score difference between pre-test score and post-test score is 29.73 and standard deviation is 7.89, *t* value is -23.84 and the significance value is less than .05. There was a clear difference between the two values of pre-test and post-test which was a 29.73. The significant difference was interpreted by the value of significance of pre-test score and post-test score which is less than .05.

4.3 Academic Achievement of Control Group

Table 4.6
Control Group Pre-Test Post-Test Mean (Paired Samples Statistics)

Group (Pair)	*N*	*M*	*SD*	*SEM*
Pre-Control	40	35.9000	9.41303	1.48833
Post-Control	40	53.5750	5.66993	0.89649

Note. M=mean; *SD*=standard deviation; *SEM*= standard error mean

Table 4.6 indicates that there were 40 students in the control group who were tested before and after the experimentation. The pre-test mean marks of the control group was 35.90 and the mean marks in post-test of the same group after treatment was 53.58. The standard deviation of the pre-control and the post-control groups were 9.41 and 5.67

respectively. Moreover, the standard error mean of the pre-control and the post-control groups were 1.49 and 0.89 respectively.

The difference in the mean scores (17.68) indicate that there was improvement in the students' academic achievement before and after the experimentation, but this result shows control group has less mean scores as compared to experimental group after treatment. The control group was treated with the traditional teaching method.

Table 4.7
*Control Group Pre-Test, Post-Test Correlation (*Paired Samples Correlations)

Group (Pair)	*N*	Correlation(*r*)	*Sig.*
Pre-Control & Post-Control	40	.416	.008

Table 4.7 indicates the correlation between pre-test and post-test in the control group. The correlation coefficient (*r*) value between pre-test and post-test was .42 which shows a low positive association between them. Which indicate less improvement in student academic achievement from pre-test to the post test. In addition, the significance level is .008, which is less than the alpha value. In this context, a significant value that is less than the alpha value (.05) indicates a weak significant difference in the academic performance of the control group students before and after the treatment.

Table 4.8
Control Group Pre-Test, Post-Test Comparison t Test (Paired Samples Test)

Group (Pair)	*M*	*SD*	*SEM*	*95% CI*		*t*	*df*	*Sig.(2-tailed*
				L L	*UL*			
PreCon & PostCon	-17.68	8.74	1.38	-20.47	-14.88	-12.79	39	.001

Note. M=mean; *SD*=standard deviation; *SEM*=standard error mean; *CI*=confidence interval; *LL*= lower limit; *UL*=upper limit

Table 4.8 shows that mean score difference between pre-test score and post-test score is -17.68 and standard deviation is 8.74, *t* value is -12.79. There was a clear difference between the two values of pre-test and post-test. The significant difference was

interpreted by the value of significance of pre-test score and post-test score which was less than .05.

4.4 Academic Achievement Comparison of Experimental and Control Group

Table 4.9
Experimental and Control Group Achievement Mean (Group Statistics)

Group	*N*	*M*	*SD*	*SEM*
Experimental	40	65.5000	5.76906	0.91217
Control	40	53.5750	5.66993	0.89649

Note. M=mean; *SD*=standard deviation; *SEM*= standard error mean

Table 4.9 shows that there were same number of students in the control and experimental groups who were tested after the experimentation. The mean score of the experimental group was 65.50 and the mean score of the control group was 53.58. The standard deviation value of the experimental and the control groups were 5.77 and 5.67 respectively. Moreover, the standard error mean of the experimental and the control groups were 0.91 and 0.89 respectively. The mean value of results for the two groups showed that there was significant difference in the mean scores of the experimental group and the control group after the treatment. Therefore, the null hypothesis, "there is no significant difference between mean post-test scores for students' taught through 5E's instructional model and traditional teaching method", was rejected.

Table 4.10
Experimental and Control Group Post-Test Mean (Independent Samples Test)

	Levene's test		*t*-test for equality of means						
Group	*F*	*Sig.*	*T*	*df*	*Sig.(2-tailed)*	*MD*	*SED*	*95%CI*	
								LL	*UL*
Scores	.070	.79	9.32	78	.001	11.93	1.27	9.37	14.47

Note. MD=mean difference; *SED*=standard error difference; *CI*=confidence interval; *LL*= lower limit; *UL*=upper limit

It is clear from table 4.10 that the mean difference in post-test of experimental group and control group after the treatment was 11.93 and the standard error difference was 1.27. The t value was 9.32 and the significance level was .001 which is less than .05. It was interpreted that there was a significant difference in the achievements of control group and experimental group after the treatment. It was observed that there was a significant difference between effectiveness of 5E's instructional model and traditional teaching method on students' achievements.

4.5 Retention Test of Experimental Group

Table 4.11
Experimental Group Post-Test Retention-Test Mean (Paired Samples Statistics)

Group (Pair)	*N*	*M*	*SD*	*SEM*
Post-Experimental	40	65.5000	5.76906	0.91217
Retention-Experimental	40	57.0750	5.83266	0.92222

Note. *M*=mean; *SD*=standard deviation; *SEM*= standard error mean

Table 4.11 indicates that there were 40 students in the experimental group who were tested for retention after four weeks of the post-test. The mean scores of post-test of experimental group was 65.50 and the mean scores of retention test of the same group was 57.08. The value of standard deviation mean scores of post-test and retention test were 5.77 and 5.83 respectively. Moreover, the standard error mean of the post-test and the retention test were 0.91 and 0.92 respectively.

The mean scores difference of both tests (8.43) indicate that there was no big difference in the scores of students in post-test and retention test. Therefore, it is concluded that the students who were taught with the help of 5E's instructional model, retain their knowledge and showed better scores after four weeks from the conduction of post-test.

Table 4.12
Experimental Group Post-Test Retention-Test Correlation (Paired Samples Correlations)

Group (Pair)	*N*	Correlation(*r*)	*Sig.*
Post-Experimental & Retention-Experimental	40	.563	.001

Table 4.12 indicates the correlation between post-test and retention test in the experimental group. The correlation coefficient (*r*) value between post-test and retention test was .56 which shows a moderate positive association between them. Which indicates about students' retention knowledge. In addition, the significance level is .001, which is less than the alpha value. In this context, a significant value that is less than the alpha value (.05) indicates a significant association found between the post-test and retention test of the experimental group.

Table 4.13
Experimental Group Post-Test, Retention Test Comparison t Test (Paired Samples Test)

Group (Pair)	*M*	*SD*	*SEM*	*95% CI*		*t*	*df*	*Sig.(2-tailed*
				L L	*UL*			
PostExp & RententionExp	8.43	5.42	0.86	6.69	10.16	9.82	39	.001

Note. *M*=mean; *SD*=standard deviation; *SEM*=standard error mean; *CI*=confidence interval; *LL*= lower limit; *UL*=upper limit

Table 4.13 shows that mean score difference between post-test and retention test score is 8.43 and standard deviation is 5.42, t value is 9.82. There was a very less difference between the two values of post-test and retention test which was 8.43. There was no significant difference was interpreted by the value of significance of post test score and retention-test score.

4.6 Retention Test of Control Group

Table 4.14
Control Group Post-Test Retention-Test Mean (Paired Samples Statistics)

Group (Pair)	*N*	*M*	*SD*	*SEM*
Post-Control	40	53.5750	5.66993	0.89649
Retention-Control	40	37.3500	4.63847	0.73341

Note. *M*=mean; *SD*=standard deviation; *SEM*= standard error mean

Table 4.14 indicates that there were 40 students in the control group who were tested for retention after four weeks of the post-test. The mean scores of post-test of control group was 53.58 and the mean scores of retention test of the same group was 37.35. The value of standard deviation mean scores of post-test and retention test were 5.67 and 4.64 respectively. Moreover, the standard error mean of the post-test and the retention test were 0.89 and 0.73 respectively.

The mean scores difference of both tests (16.23) indicate that there was big difference in the scores of students in post-test and retention test. Therefore, it is concluded that the students who were taught with the help of traditional teaching method, did not retain their knowledge properly and showed less scores after four weeks from the conduction of post-test.

Table 4.15
*Control Group Post-Test Retention-Test Correlation (*Paired Samples Correlations)

Group (Pair)	*N*	Correlation(*r*)	*Sig.*
Post-Control & Retention-Control	40	.393	.009

Table 4.15 indicates the correlation between post-test and retention test in the control group. The correlation coefficient (*r*) value between post-test and retention test was .39 which shows a low positive association between them. This indicates about students' less retention knowledge in a group. In addition, the significance level is .009, which is less than the alpha value. In this context, a significant value that is less than the alpha

value (.05) indicates a weak significant association found between the post-test and retention test of the control group.

Table 4.16
Control Group Post-Test Retention Test Comparison t Test (Paired Samples Test)

Group (Pair)	*M*	*SD*	*SEM*	*95% CI*		*t*	*df*	*Sig.(2-tailed*
				L L	*UL*			
PostCon & RententionCon	16.23	4.75	0.75	11.7	14.7	19.6	39	.001

Note. *M*=mean; *SD*=standard deviation; *SEM*=standard error mean; *CI*=confidence interval; *LL*= lower limit; *UL*=upper limit

Table 4.16 shows that mean score difference between post-test and retention score is 16.23 and standard deviation is 4.75, *t* value is 19.6. There was a clear difference between the two values of post-test and retention test which was 16.23. The significant difference was interpreted by the value of significance of post-test and retention score which was less than .05.

4.7 Comparison of Experimental and Control Group Retention Test

Table 4.17
Experimental and Control Group Achievement Mean (Group Statistics)

Group	*N*	*M*	*SD*	*SEM*
Experimental Retention	40	57.0750	5.83266	0.92222
Control Retention	40	37.3500	3.63847	0.53341

Note. *M*=mean; *SD*=standard deviation; *SEM*= standard error mean

Table 4.17 shows that there were same number of students in the control and experimental groups who were tested after four weeks of post-test for retention. The mean score of the experimental retention group was 57.08 and the mean score of the control retention group was 37.35. The standard deviation value of the experimental and the control retention groups were 5.83 and 3.64 respectively. Moreover, the standard error mean of the experimental and the control retention groups were 0.92 and 0.53 respectively. The mean difference (19.73) in two groups showed that there was significant difference in the mean scores of the experimental group and the control

group after the retention. Therefore, the null hypothesis, "there is no significant difference between mean retention scores for students' taught through 5E's instructional model and traditional teaching method", was rejected.

Table 4.18
Experimental and Control Group Retention Test Mean (Independent Samples Test)

	Levene's test		*t*-test for equality of means						
Group	*F*	*Sig.*	*T*	*df*	*Sig.(2-tailed)*	*MD*	*SED*	*95%CI*	
								LL	*UL*
Scores	3.72	.09	16.19	78	.001	19.73	1.17	14.37	19.07

Note. MD=mean difference; *SED*=standard error difference; *CI*=confidence interval; *LL*= lower limit; *UL*=upper limit

It is clear from table 4.18 that the mean difference in retention test of experimental group and control group after four weeks of post-test was 19.73 and the standard error difference was 1.17. The *t* value was 16.19 and the significance level was .001 which is less than .05. It was interpreted that there was a significant difference in the achievements of control group and experimental group in the retention test. It was observed that there was a significant improvement and consistency in the learning of students based on 5E's instructional model of teaching method as compared to traditional teaching method.

CHAPTER 5

SUMMARY, FINDINGS, DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

The present chapter includes a summary, research findings, a discussion of findings and at last the recommendations given to the different stakeholders in the field of education. These are related to the data analysis and interpretation that the researcher discussed in the previous chapter.

5.1 Summary

This study was conducted to determine the "Effects of 5E's Instructional Model on Academic Achievement in 10^{th} grade Chemistry". Three units were included from the Chemistry textbook of class 10^{th} for this experimental study. The textbook was published by the National Text Book Foundation, Islamabad in 2022. The researcher developed lesson plans from these three units to treat the experimental and control groups. Expert opinions were also taken to develop the lesson plans. A pre-test used as a research instrument was developed by the researcher. It was applied before and after the intervention as the pre-test and the post-test respectively. A retention test was also conducted after four weeks from the post-test of experimental and control groups. Moreover, pilot testing was conducted for the reliability of the research instrument. The split-half method was applied for the reliability of the research instrument.

All the secondary-level science students male who were enrolled in the public sector, were administered by the Federal Directorate of Education, Islamabad, considered as the target population of the study. The Researcher selected one government boy's high school Islamabad Model School for Boys (vi-x), Noor Pur Shahan, by simple random sampling technique for the conduction of the experiment. A sample size of the study consisted of all 80 students from this school. The researcher divided the sample into two equal experimental and control groups by equating them

based on pre-test scores. On the basis of pre-test scores two equal groups were formed, one known as control and the second experimental. Both groups were treated by the researcher himself. The experimental group was treated by the researcher for 5E's instructional teaching model. However, the control group was taught by the researcher through the traditional teaching method.

After collecting data from the post-test, the data were analysed through SPSS (Version-22). The descriptive analysis was used to calculate the measures of central tendency (mean) and measures of dispersion (Standard Deviation). The researcher also applied a dependent *t*-test to compare the achievement of students of the same group in the pre-test and post-test. Another inferential statistic test was used called the independent sample *t*-test, which is a statistical test to compare the achievements of experimental and control groups and to determine the significant difference in both groups. The above-mentioned tests were applied with the help of SPSS (Version-22). Based on the analysis of data, the findings of the study were obtained.

5.2 Findings of the Study

The researcher drew the following findings from the analysis of the data in the study.

1. Basic abilities and concepts of the Chemistry of experimental and control groups were determined before the treatment. From the result, it was found that there was a very minor difference in mean scores (0.13) of the experimental and control groups because the mean scores of pre-test in the experimental and control groups were 35.77 and 35.90 respectively (Table 4.1), in addition, the inferential analysis in the same table confirms the comparison of both groups and declared that there was no significant difference between the experimental and control groups before the treatment. The *p*-value (.95) is greater than the

alpha value .05(p>.05). Furthermore, the Bonferroni correction was applied on the alpha level at .05, experimental wise error and the adjusted level of statistical significance was .05/6=.0083 (a=.0083), found. After Bonferroni adjustment the p-value (.95) is remained greater than the alpha value .0083(p>.0083) which also proved that there was no significant difference between the experimental and control groups before the treatment.

2. To investigate the effect of 5E's instructional model on students' academic achievement in 10th grade Chemistry (objective 1). Through the analysis, it was found that the experimental group achieved significantly better in the post-test as compared to the pre-test. Moreover, the correlation of 40 students appears positive moderate (.57) which shows the achievement in the post-test. In this continuation, a significant difference was found (29.73) in the mean scores of the pre-test and post-test (Table 4.3). It was found that students at secondary level improved in the subject of Chemistry by applying 5E's instructional model in the classroom.
3. Objective No.2 of the study was to find out the effect of traditional teaching method on students' academic achievement in 10th grade Chemistry. It was found that the achievement scores through the traditional teaching method in the control group indicated the difference in scores before and after the treatments. The findings of table 4.6 indicated the difference in scores before and after the treatment in the control group. The difference in mean scores (17.68) indicated that the control group also improved after the treatment. Additionally, the correlation of 40 candidates score was .42 which shows a low positive correlation increasing the achievements of the sample before and after

the treatment. The difference in the scores of the pre-test and the post-test confirms students' better academic achievement in the post-test.

4. To compare the effect of 5E's instructional model and traditional teaching method on students' academic achievement in 10th grade Chemistry (objective 3), it was found that the significant academic achievement difference in the experimental group and control group was found after intervention through 5E's instructional model and traditional teaching method respectively. The descriptive and inferential statistical analysis of post-test scores in experimental and control groups found the mean score difference which is 11.93 and *p*-value (.001) is less than .05($p<.05$) which indicates that there is a significant difference in the academic achievement of experimental group and control group (Table 4.10). Furthermore, the Bonferroni correction was applied on the alpha level at .05, experimental wise error and the adjusted level of statistical significance was .05/6=.0083 ($a=.0083$), found. After Bonferroni adjustment the *p*-value (.001) is remained less than the alpha value .0083($p<.0083$) which also proved that there is a significant difference in the academic achievement of the experimental group and control group.
5. Objective No.4, to compare the effect of 5E's instructional model and traditional teaching method on the students' retention in 10th grade Chemistry. After the results of the post-test and comparison of achievements, a retention test was conducted in experimental and control groups after four weeks of the post-test. The purpose of the retention test was to check the stability and deep learning of the students. It was found that there was no significant difference in post experimental and retention experimental groups. The mean difference between post-test and retention test in the experimental group was found 8.43

with a positive correlation (.56). *p*-value was .001 which is less than alpha value .05($p<.05$), which indicates that there was no significant difference in mean scores after four weeks (Table 4.11 & Table 4.12). Furthermore, the Bonferroni correction was applied on the alpha level at .05, experimental wise error and the adjusted level of statistical significance was .05/6=.0083 ($a=.0083$), found. After Bonferroni adjustment the *p*-value (.001) is remained less than the alpha value .0083($p<.0083$) which also proved that there was no significant difference in mean scores after four weeks.

6. It was found that there was a significant difference in the control group between the post-test and retention test. The mean difference of the post-test and retention test in the control group was found 16.23 with a low positive correlation (.39). *p*-value was .001 which is less than alpha value .05($p<.05$) which indicates that there was a significant difference in mean scores after four weeks (Table 4.14 & Table 4.15). Furthermore, the Bonferroni correction was applied on the alpha level at .05, experimental wise error and the adjusted level of statistical significance was .05/6=.0083 ($a=.0083$), found. After Bonferroni adjustment the *p*-value (.001) remained less than the alpha value .0083($p<.0083$) which indicates that there was a significant difference in mean scores after four weeks.

5.3 Discussion

The purpose of this experimental research was to find out the effectiveness of the 5E's instructional model on students by applying inquiry-based and constructivist teaching strategies in the experimental group and traditional teaching method through rote learning and drill-based strategies in the control group. The researcher selected the subject of Chemistry for experimental research at the secondary level in Islamabad. The

major objectives of the experimental study were to investigate the effect of 5E's Instructional Model on students' academic achievement in 10th grade Chemistry, to find out the effect of Traditional Teaching Method on students' academic achievement in 10th grade Chemistry, to compare the effect of 5E's Instructional Model and Traditional Teaching Method on students' academic achievement in 10th grade Chemistry and to compare the effect of 5E's Instructional Model and Traditional Teaching Method on the students' retention in 10th grade Chemistry. Through the pre-test of students, it was confirmed that both the experimental and control groups were the same but after the application of 5E's instructional model by inquiry and constructivism based teaching method in the experimental group at the secondary level, the significant difference acquired in the scores of academic achievement in Chemistry. This result confirms the previous study conducted by Umahava (2018), who concluded that the experimental group of students at the secondary level performed significantly better than the control group due to the application of the 5E's instructional model in developing inquiry-based learning among secondary level students.

This study supports the results of Ibrahim (2015), who argued that students can explore and discover the basic concepts of the content by themselves by asking questions, searching, using prior knowledge, connecting it to everyday life, building a device, and analyzing an experiment independently. The 5E learning model is, therefore, a successful learning model. In the 5E learning model, there should be a change in students' conceptual framework, and the teacher helps his students create their concepts through a series of steps. The Government of Pakistan has also recognized the importance of conceptual learning. In Pakistan, Khalid (2012) reported that government authorities are determined to ensure the implementation of concept teaching. The curriculum was therefore developed to emphasize that concept formation

is central to science learning instead of overwhelming students with unnecessary and often unrelated details. The vision emerging from the findings reveals that the 5E learning model is an effective and useful learning model for reinforcing students' previous concepts and for understanding new, original and complex concepts.

The results of this study are similar to the findings of Belapurkar (2017), who noted that conceptual change is facilitated by a teaching model that uses the learning cycle, is built on constructivism, and includes the foundations of the 5E teaching model. This learning cycle is one of the latest important versions of the learning model. Teaching should aim at clarifying students' misconceptions and establishing new thoughts and ideas that are translated into concepts. One of the important benefits of the 5E learning model is a suitable foundation that creates reliable, consistent mental structures. A cluster of new appropriate concepts is constructed based on reliable mental constructs or structures.

Several studies have shown a positive relationship between the 5Es learning cycle and student achievement. For example, Sen & Oskay (2017); Belapurkar (2017); Cheta & Chidinma (2018); Tonseenon (2017); and Magak (2016) favored the view constructivist approaches have been found to be successful for the formation of scientific concepts. This study also reports that the 5E instructional model is an effective and useful instructional model with comparable judgment that the 5E instructional model presented an encouraging impact on student achievement. The results also showed that the 5E instructional model seems to be approved for improving the ability to build concepts and to eliminate misconceptions even among students with lower cognitive abilities.

This study supports the results of Acish et al. (2011), who argued that students can explore and discover basic content concepts on their questioning, searching, using

previous knowledge, connecting it with everyday life, compiling equipment and analyze the experiment separately. So, the 5E learning model is a successful teaching model. A change in students' conceptual framework should occur in the 5E learning model and the teacher helps his students create their concepts through a series of steps. The Government of Pakistan also recognized the importance of conceptual teaching.

This study also supports the results of Javed (2012), who tested learning model for science teaching at the primary level is effective. This research was based on an experiment having pre-test and post-test group design. Learning model dimensions were used in the teaching of experimental and control groups. The result of the learning model study followed the experimental group showing excellent performance in the post-test by achieving good scores as compared to the controlled group.

This study supports the results of Bunkure (2012), on the retention knowledge of the students, the students of the experimental group in the retention test were also better than the control group students. So the preservation of knowledge about the experimental group was also found to be better than the control group.

Although most of the research studies results nearly match with that research study, on the other side there are a few potential limitations which are also discussed here, e.g., the population is chosen limited due to socio-cultural conditions. Only boys are selected from the public schools, secondly, private schools are not part of this study. Only one school is selected for the experiment, due to that contrasting results are not obtained. Secondly, the research instrument only contains selected type items, restricted and open response items are missing. That’s why researchers gave recommendations for future researchers to do their studies according to requirements, in this way better results may be obtained in the future.

The study investigated that students had a weak understanding of chemistry concepts, as indicated by the significantly low results of the pre-tests. However, after implementing the 5Es learning model, students showed improvement and scored well in the chemistry post-test and retention test. This improvement was attributed to the added clarity of concepts elicited in the stages of the 5Es learning model.

5.4 Conclusions

The findings of the study by the researcher have been concluded as follows:

1. It is concluded that both the experimental and control groups had the same basic abilities and understanding of Chemistry before the intervention. The results showed that there was no significant difference in the students' learning before the intervention.
2. To investigate the effect of 5E's instructional model on students' academic achievement in 10^{th} grade Chemistry. From the findings, it is revealed that the experimental group achieved significantly better in the post-test as compared to the pre-test. It is concluded that the students at the secondary level can achieve better knowledge in the subject of Chemistry by applying 5E's instructional model in the classroom.
3. To find out the effect of traditional teaching method on students' academic achievement in 10^{th} grade Chemistry. It is concluded that the achievement scores through the traditional teaching method in the control group indicated a low significant difference in scores before and after the treatment. The low significant difference in the scores of the pre-test and the post-test confirms that students achieved less significantly in the post-test.
4. To compare the effect of 5E's instructional model and traditional teaching method on students' academic achievement in 10^{th} grade Chemistry, it is

concluded that a significant academic achievement difference in the experimental and control group was found after intervention through 5E's instructional model and traditional teaching method respectively. Students in experimental group performed better because the 5E's instructional model has several advantages like encouraging students to develop their understanding and perceptions. It also allows the teaching environment to be organized around targeted concepts and supports the use of different strategies by facilitating an integrated teaching approach. It developed interest in learning of the students due to student centred approach. It is concluded that if teachers have a framework for five stage learning activities in a 5E's instructional model students will perform better as compared to the lecture method. It also respects students' differences, ensures the transition from subjectivity to objectivity for integrated learning, and improves the holistic thinking style.

5. The retention test confirmed the effectiveness of the 5E instructional model of teaching. After analyzing the post-test results and comparing the achievements, a retention test was conducted in both the experimental and control groups four weeks after the post-test. The purpose of the retention test was to assess the students' retention and depth of learning. It was concluded that there was no significant difference between the post-experimental and retention experimental groups.
6. It is concluded that the lecture method enhances rote memorization and surface learning because there was a significant difference in the control group between the post-test and retention test after a period of four weeks. Students have less ability for deep understanding.

5.5 Recommendations

The result of this experiment shows that the academic abilities of students in the experimental group and control group were similar before the intervention, but there was a significant difference between the two groups after the intervention. This indicates that 5E's instructional model develops inquiry-based and constructive thinking among students at the secondary level. The constructivist 5E's instructional model is investigated to be an effective model for helping students improve their learning and achieve the highest academic scores**.** The significant results of the study show that this model is effective in the development of constructivist and inquiry-based learning among students at the secondary level in the subject of Chemistry. The recommendations for different stakeholders in education are explained below:

5.5.1 Recommendations for teachers

According to the latest research, teaching and learning is a collaborative process, it occurs well when teachers and learners show their active role in this process. Hence, teachers should learn inquiry-based and critical thinking skills to teach the students, especially at the secondary level to teach science subjects. The current experimental study confirmed that the students who were treated with 5E's instructional model achieved better scores than the other group of students who were treated with the traditional teaching method. From this conclusion, the following is recommended:

1. Secondary school teachers may be trained with inquiry and constructivist based skills to apply them in their classrooms. Furthermore, it is also suggested that the inquiry-based 5E's instructional model may be introduced in the pre-service and the in-service teachers' training programs by the Federal College of Education (FCE), Islamabad and Allama Iqbal Open University (AIOU), Islamabad.

2. Inquiry and constructivist teaching strategies are learner-centred approaches that are suitable for developing logical thinking among students. Therefore, it is suggested that secondary level teachers apply inquiry-based learning strategies in the teaching of Chemistry to improve the active learning of students.
3. The science teachers should create an environment where students can freely ask questions, think differently, be physically and cognitively active, and solve academic and social problems through diverse thinking and sound decision-making.

5.5.2 Recommendations for students

The students should think logically in science subjects like Chemistry, Biology, and Physics etc. to clarify academic problems and also to attain maximum learning. Due to that reason, they must contribute enthusiastically to the learning activities and construction of knowledge. Hence, they are suggested:

1. The learners should learn about the applicability of constructivist inquiry-based 5E's instructional model for the in-depth knowledge of subject matter and making solutions of daily life matters.
2. Professionals ask the right questions, use logic to answer the questions and draw conclusions that solve the problem. Students may improve positive and logical thinking by using 5E's instructional model.
3. Proper and logical learning cannot happen passively. The students must show their participation actively during lectures through positive discussion, logical questioning and proper reflection.
4. Students of all abilities, whether high achievers, average achievers, or low achievers, are recommended to use 5E's inquiry-based instructional model to

develop positive and logical thinking. Furthermore, extrinsic motivation from teachers and parents can also encourage self-control and positive thinking in students.

5.5.3 Recommendations for curriculum developers

The main purpose of education is to produce professional and useful people in any society. Poor education and poor communities indicate that there is a problem with education. Therefore, curriculum designers and textbook writers can solve these problems. The results of this experimental study suggests reducing this problem by introducing 5E's Instructional Model in the development of science curriculum. From this conclusion, the following is recommended:

1. It is essential and needs of time to improve the textbook of "Chemistry" according to inquiry-based and constructivist instructional manner instead of lecture-based instructional strategies. Therefore, a team of specialists may be selected for preparation of text book of Chemistry at the secondary level.
2. The textbook of Chemistry should have assessment exercises that may reflect the five phases of instructional standards which promote inquiry-based learning and critical thinking among students. These recommendations may be attained by professional development of textbook authors and curriculum designers by Federal Ministry of Education and Professional Development, Curriculum Wing, Islamabad.
3. It is the key responsibility of the Federal Board of Intermediate and Secondary Education (FBISE), Islamabad to provide proper training to paper setters of science subjects especially Chemistry about the instructional model and how to evaluate the knowledge of students in a logical way.

5.5.4 Recommendations for future researchers

This experimental study concludes that 5E's instructional inquiry-based model enhances the academic achievement of science students in Chemistry at the secondary level. This experimental study may offer a new platform for upcoming researchers. Therefore, the valuable recommendations for future researchers are given below:

1. A similar study may be repeated with different populations to confirm the results of the current experimental study.
2. The researchers can conduct this experimental study at other levels also e.g., primary, middle and higher secondary levels because this study is delimited to secondary schools' level.
3. This experimental study was conducted to find out the effectiveness of 5E's instructional model at the secondary level in the subject of Chemistry. The other science subjects e.g., Biology, Physics, Computer Science and Mathematics may also be investigated by this model.
4. This experimental study may be carried out in girls' schools, as this research study is delimited to only one boys' school. Furthermore, boys' and girls' school result findings are also compared with each other.
5. This experimental study may also be conducted in private schools, as this research study is delimited to only boys' public schools. Furthermore, private and public schools result findings are also compared with each other.
6. This study can be conducted in other provinces of Pakistan e.g., Punjab, Khyber PakhtonKhwa (KP), Balochistan and Sindh as this study is delimited to Islamabad and their results are also compared with each other.
7. The test instrument used in this study consisted of selected response items (MCQs) only, the upcoming researchers can conduct this study by restricted

response items and extended response items along with selected response items for more appropriate results.

8. For more in-depth investigation, qualitative research can be conducted to examine the effectiveness of 5E's instructional model.

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APPENDICES

Appendix 1

Lesson Plan No.1 (Experimental Group)

Name of Teacher: Irshad Hussain **Subject:** Chemistry **Topic:** Concept of Acids and Bases **Grade:** 10th **Lesson Time:** 40 Minutes **Total Students:** 40	
Objectives	**General Objectives:** 1) To develop the interest in students for learning Chemistry through activities. 2) Organize 5E's instructional based strategies for learners to learn the concepts present in text book of Chemistry. 3) Create a culture of active environment among students studying Chemistry at secondary level. 4) To promote inquiry based and constructivist learning in the classroom for teaching Chemistry. **Specific Objectives:** After going through this lesson, the students will be able to: 1) Define the terms acids and bases. 2) Comprehend and elaborate the concept of acids and bases with suitable daily life examples. 3) Investigate the importance of acids and bases in daily life. 4) Identify acids and bases with the use of litmus paper and indicators.

	5) To find out the strengths of acids and bases with the help of litmus paper.
Audio Visual Aids	Text books, litmus papers (blue and red), indicators, beakers containing acids and bases solutions, white board and marker etc.
Presentation	The delivering of lesson by using 5E's Instructional Model to the experimental group has the following steps. Engagement, Exploration, Explanation, Elaboration and evaluation.
Engagement (05 minutes)	In this stage, the teacher will use "brain storming technique" in order to explore students' current knowledge about the topic. In this way teacher starts the lesson with the help of some questions. "What are the acids and bases we often use in our daily life?" Give examples. "Is the toothpaste base? Students will be asked to think and write the possible reasons for them. Teacher now will write the today's topic "Concept of Acids and Bases" on white board.
Exploration (15 minutes)	At this stage, all students will work in groups. Experimental materials, 05 beakers containing acid and base solution, blue and red litmus paper, set of indicators, will be given to the groups and then they will be given an experimental procedure explaining the steps. Each group does the activities, write down their observations, and discuss their results to reach a final conclusion.
Explanation (10 minutes)	At this stage, the groups will present their results to the whole class. After the presentations, the teacher starts a whole-class discussion by asking questions about the results of each group. Also, the

	teacher uses examples and questions from daily life to support the discussion. The discussion tries to produce a joint decision.
Elaboration (05 minutes)	At this stage teacher will relate the topic with the daily life examples. Asking questions like, Why are acids and bases relevant to life? What is acid rain? How it affects our environment. Students will then pick a partner and both will teach each other about what they learnt about how acids and bases are relevant.
Evaluation (05 minutes)	At this stage, the following questions will be asked to clarify whether the students have learned. 1) Define acids and bases. 2) Identify an acid and base. 3) Recognize how an acid and base behaves in solution. 4) What is the effect of blue litmus paper in acidic solution? After evaluation, the teacher will conclude the lesson by giving the students home task.

Lesson Plan No.2 (Experimental Group)

Name of Teacher: Irshad Hussain **Subject:** Chemistry **Topic:** Concept of Air Pollutants **Grade:** 10th **Lesson Time:** 40 Minutes **Total Students:** 40	
Objectives	**General Objectives:** 1) To develop the interest in students for learning Chemistry through activities. 2) Organize 5E's instructional based strategies for learners to learn the concepts present in text book of Chemistry. 3) Create a culture of active environment among students studying Chemistry at secondary level. 4) To promote inquiry based and constructivist learning in the classroom for teaching Chemistry. **Specific Objectives:** After going through this lesson, the students will be able to: 1) Define air pollutant. 2) Understand the characteristics of major air pollutants. 3) What is the negative effect of ozone on humans? 4) Comprehend and elaborate the concept of air pollutants with daily life examples. 5) Identify the main causes of air pollution. 6) Investigate the effects of air pollutants on human beings, animals, plants and our atmosphere. 7) Identify the ways, how to overcome the issue of air pollution.

Audio Visual Aids	Text books, charts, global warming model, short video about air pollutants, white board, smoke source, cigarette, and marker etc.
Presentation	The delivering of lesson by using 5E's Instructional Model to the experimental group has the following steps. Engagement, Exploration, Explanation, Elaboration and evaluation.
Engagement (05 minutes)	In this stage, the teacher will use "brain storming technique" in order to explore students' current knowledge about the topic. In this way teacher starts the lesson with the help of some questions. 1) What is pollution? 2) Which are the main types of pollution. 3) Smog belongs to which type of pollution. 4) Think of a situation when you are in a park and in second case you are near garbage dump. Where would you feel fresh and why? Students will be asked to think and write the possible answers with suitable reasons for them. Teacher now will write the today's topic "Concept of Air Pollutants" on white board.
Exploration (15 minutes)	At this stage, all students will work in groups. Each group will be assigned one air pollutant e.g.; carbon monoxide, they worked on them properly, in this way help from the short videos will also be taken to understand the material logically and deeply. Activity materials, will be given to the groups and then they will be given a procedure explaining the steps. Each group does the activities, write down their observations, and discuss their results to reach a final conclusion.

Explanation (10 minutes)	At this stage, the groups will present their assigned topic to the whole class. After the presentations, the teacher starts a whole-class discussion by asking questions about the assigned topics of each group. Moreover, the teacher uses examples and questions from daily life to support the discussion. The discussion tries to produce a joint decision.
Elaboration (05 minutes)	At this stage teacher will relate the topic with the daily life examples. Asking questions like, Why air pollutant affects our environment and life? What is global warming? How it affects our environment. Students will then pick a partner and both will teach each other about what they learned about air pollutants and their effects on our environment.
Evaluation (05 minutes)	At this stage, the following questions will be asked to clarify whether the students have learned. 1) Define air pollutant. 2) What is the difference between pollutant and air pollutant? 3) Tell the names of major air pollutants. 4) What is the negative effect of ozone on humans? After evaluation, the teacher will conclude the lesson by giving the students home task.

Lesson Plan No.3 (Experimental Group)

Name of Teacher: Irshad Hussain **Subject:** Chemistry **Topic:** Concept of Soft and Hard Water **Grade:** 10th **Lesson Time:** 40 Minutes **Total Students:** 40	
Objectives	**General Objectives:** 1) To develop the interest in students for learning Chemistry through activities. 2) Organize 5E's instructional based strategies for learners to learn the concepts present in text book of Chemistry. 3) Create a culture of active environment among students studying Chemistry at secondary level. 4) To promote inquiry based and constructivist learning in the classroom for teaching Chemistry. **Specific Objectives:** After going through this lesson, the students will be able to: 1) Define term soft and hard water. 2) Understand the characteristics of soft and hard water. 3) Differentiate between temporary and permanent hardness of water. 4) Explain the negative effects of hard water. 5) Comprehend and elaborate the concept of soft and hard water with daily life examples. 6) Identify the main causes of hardness in water.

	7) Investigate the effects of hard water on human beings, animals and plants.
Audio Visual Aids	Text books, beakers containing soft and hard water, empty beakers, soap, detergent, distilled water, tap water, boiled water, short video about soft and hard water, chart of water cycle, calcium and magnesium bicarbonates, calcium and magnesium chlorides, calcium and magnesium sulphates, white board and marker etc.
Presentation	The delivering of lesson by using 5E's Instructional Model to the experimental group has the following steps. Engagement, Exploration, Explanation, Elaboration and evaluation.
Engagement (05 minutes)	In this stage, the teacher will use "brain storming technique" in order to explore students' current knowledge about the topic. In this way teacher starts the lesson with the help of some questions. 1) What are the main sources of water? 2) What you know about quality of water? 3) Why all water in the world not fit for drinking purposes? 4) The pan which is regularly used for boiling water gets white or yellowish deposits at its bottom and sides? Explain why. 5) Which water is soft, tap water or distilled water? Explain why. Students will be asked to think and write the possible answers with suitable reasons for them. Teacher now will write the today's topic "Concept of Soft and Hard Water" on white board.
Exploration (15 minutes)	At this stage, all students will work in groups. Experiment materials, 02 beakers containing soft and hard water, empty beakers soap, set of salts, will be given to each group and then they will be given an

	experimental procedure explaining the steps. Short video also seen during this session. Each group does the activities, write down their observations, and discuss their results to reach a final conclusion.
Explanation (10 minutes)	At this stage, the groups will present their results to the whole class. After the presentations, the teacher starts a whole-class discussion by asking questions about the results of each group. Furthermore, the teacher uses examples and questions from daily life to support the discussion. The discussion tries to produce a joint decision.
Elaboration (05 minutes)	At this stage teacher will relate the topic with the daily life examples. Asking questions like, How soft and hard water affect our environment and life? What is acid rain? How it affects our environment. What is the effect of water as a universal solvent on water harness? Students will then pick a partner and both will teach each other about what they learned about soft and hard water and their characteristics.
Evaluation (05 minutes)	At this stage, the following questions will be asked to clarify whether the students have learned. 1) Define soft and hard water. 2) What is the function of boiling in purification of water? 3) Name the types of hard water. 4) What are the reasons for temporary hardness in water? 5) What are the reasons for permanent hardness in water? After evaluation, the teacher will conclude the lesson by giving the students home task.

Appendix 2

Lesson Plan No.1 (Control Group)

Name of Teacher: Irshad Hussain **Subject:** Chemistry **Topic:** Concept of Acids and Bases **Grade:** 10th **Lesson Time:** 40 Minutes **Total Students:** 40	
Objectives	**General Objectives:** 1) To develop the interest in students for learning Chemistry. 2) Construct traditional instructional strategies for learners to learn the ideas present in text book of Chemistry. 3) Create a culture of passive environment among students studying Chemistry at secondary level. 4) To promote rote-learning in the classroom for teaching Chemistry topics. **Specific Objectives:** After going through this lesson, the students will be able to: 1) Define and give few examples of acids and bases. 2) Categorize acids and bases in a proper way according to their specific properties. 3) Understand the characteristics of acids and bases.
Audio Visual Aids	Text books, Chart, Litmus Papers (Blue and Red), beakers, White Board and Marker etc.
Introduction (03 minutes)	Teacher will ask following questions from the students to check their previous knowledge about the topic. 1) What is the taste of lemon?

	2) Which type of taste toothpaste has? 3) Lemon and toothpaste has same or different tastes?
Announcement of the topic (02 minutes)	Teacher now will write the today's topic "Concept of Acids and Bases" on the white board. The students will be asked to open page number 20 of their Chemistry textbook.
Presentation (25 minutes)	**Lecture Method** At the start of the lecture teacher forcefully ask the class to open their text books and also note books for writing down the material from the white board. During the lecture, teacher will use the question answer technique to involve the class in lecture. Teacher's main focus will be to deliver the knowledge to the students through lecture. Teacher explains the acids and bases with the help of explanation and examples which are mentioned in the text book. Teacher show the equipment like blue and red litmus paper and also explain their effect on acids and bases. **Step i:** The teacher will define an acid and base as a substance which produces hydrogen ions and hydroxyl ions respectively when dissolved in water. **Step ii:** The teacher will explain how to recognize an acid and base; an acid can be recognized by its sour taste and base by bitter taste.

	Step iii: The teacher will also explain how an acid and base behaves in a solution; an acid changes blue litmus paper to red and base red litmus to blue. **Step iv**: The teacher will describe the reaction of acids and base with metals and non-metals. Acids react with some metals to liberate hydrogen gas bases produces salts and water.
Evaluation (05 minutes)	The teacher will evaluate the lesson by asking the following questions: 1) Define acids and bases. 2) Identify an acid and base. 3) Name some common acids and bases from their daily life. 4) Recognize how an acid and base behaves in solution.
Home Task (05 minutes)	The teacher concludes the lesson by giving the students home task. 1) Write the concept of acids and bases and also their characteristics. (From page no. 20-22). 2) Learn the same work carefully.

Lesson Plan No.2 (Control Group)

Name of Teacher: Irshad Hussain **Subject:** Chemistry **Topic:** Concept of Air Pollutants **Grade:** 10th **Lesson Time:** 40 Minutes **Total Students:** 40	
Objectives	**General Objectives:** 1) To develop the interest in students for learning Chemistry. 2) Construct traditional instructional strategies for learners to learn the ideas present in text book of Chemistry. 3) Create a culture of passive environment among students studying Chemistry at secondary level. 4) To promote rote-learning in the classroom for teaching Chemistry topics. **Specific Objectives:** After going through this lesson, the students will be able to: 1) Define the term air pollutant. 2) List out the names of main air pollutants. 3) Explain effects of air pollutants.
Audio Visual Aids	Text books, Chart, White Board and Marker etc.
Introduction (03 minutes)	Teacher will ask following questions from the students to check their previous knowledge about the topic. 1) Define pollution. 2) Name the major types of pollution. 3) Smog belongs to which type of pollution.

Announcement of the topic (02 minutes)	Teacher now will write the today's topic "Concept of Air Pollutants" on the white board. The students will be asked to open page number 112 of their Chemistry textbook.
Presentation (25 minutes)	**Lecture Method** At the start of the lecture teacher forcefully ask the class to open their text books and also note books for writing down the material from the white board. During the lecture, teacher will use the question answer technique to involve the class in lecture. Teacher's main focus will be to deliver the knowledge to the students through lecture. Teacher explains the term air pollutants with the help of explanation and examples which are mentioned in the text book. **Step i:** The teacher will define the term air pollutant, "Anything present in the air which has a harmful effect on some part of the environment is called air pollutant". **Step ii:** The teacher will explain the term air pollutant in detail with the reference of major air pollutants. **Step iii:** The teacher explains air pollutants (Carbon Monoxide, Nitrogen Oxides, Sulphur Oxides, Methane, Chlorofluorocarbons, Lead Compounds and Ozone), one by one in detail and also the effects of those air pollutants on humans, animals, plants and our environment. **Step iv**: The teacher will describe how human activities link with the air pollution and how these activities enhance air pollution in our environment.

Evaluation (05 minutes)	The teacher will evaluate the lesson by asking the following questions: 1) Define air pollutant. 2) What is the difference between pollutant and air pollutant? 3) Tell the names of major air pollutants. 4) What is the negative effect of ozone on humans?
Home Task (05 minutes)	The teacher concludes the lesson by giving the students home task. 1) Write the concept of Air Pollutants and also their effects on humans, animals, plants and environment. (From page no. 112-114). 2) Learn the same work carefully.

Lesson Plan No.3 (Control Group)

Name of Teacher: Irshad Hussain **Subject:** Chemistry **Topic:** Concept of Soft and Hard Water **Grade:** 10th **Lesson Time:** 40 Minutes **Total Students:** 40	
Objectives	**General Objectives:** 1) To develop the interest in students for learning Chemistry. 2) Construct traditional instructional strategies for learners to learn the ideas present in text book of Chemistry. 3) Create a culture of passive environment among students studying Chemistry at secondary level. 4) To promote rote-learning in the classroom for teaching Chemistry topics. **Specific Objectives:** After going through this lesson, the students will be able to: 1) Define the term soft and hard water. 2) Explain the term soft and hard water in detail. 3) Understand the characteristics of soft and hard water. 4) Know the main reasons for hardness in water.
Audio Visual Aids	Text books, Chart, White Board, beakers containing soft and hard water, salts, distilled water, tap water, boiled water and Marker etc.
Introduction (03 minutes)	Teacher will ask following questions from the students to check their previous knowledge about the topic. 1) What are the main sources of water? 2) What you know about quality of water?

	3) Why all water in the world is not fit for drinking purposes?
Announcement of the topic (02 minutes)	Teacher now will write the today's topic "Concept of Soft and Hard Water" on the white board. The students will be asked to open page number 130 of their Chemistry textbook.
Presentation (25 minutes)	**Lecture Method** At the start of the lecture teacher forcefully ask the class to open their text books and also note books for writing down the material from the white board. During the lecture, teacher will use the question answer technique to involve the class in lecture. Teacher's main focus will be to deliver the knowledge to the students through lecture. Teacher explains the soft and hard water with the help of explanation and examples which are mention in the text book. **Step i:** The teacher will define the term soft water, "The water that easily gives lather with soap and does not form scum is called soft water". **Step ii:** Hard water define as, "The water that gives little lather or forms scum with soap is called hard water". **Step iii:** The teacher will also explain the terms tap water and distilled water. Explain about the boiling process, which is important for purification of water. **Step iv**: The teacher will describe the types of hardness of water, also provide brief description of temporary and permanent hardness in water.

	Step v: Teacher also explains the students, calcium bicarbonate and magnesium bicarbonate is the cause of temporary hardness in water whereas calcium chloride, magnesium chloride, calcium sulphate and magnesium sulphate is the cause of permanent hardness in water.
Evaluation (05 minutes)	The teacher will evaluate the lesson by asking the following questions: 1) Define soft and hard water. 2) What is the function of boiling in purification of water? 3) Name the types of hard water. 4) What are the reasons for temporary hardness in water? 5) What are the reasons for permanent hardness in water?
Home Task (05 minutes)	The teacher concludes the lesson by giving the students home task. 1) Write the concept of soft and hard water and also the types of hardness in water. (From page no. 130-132). 2) Learn the same work carefully

Appendix 3

Pre-Test

Name: …… Time allowed: 120 minutes Class: 10th

Roll No: ……... Group: …… Marks: 100

Note: Encircle the correct option. Overwriting is not allowed.

1. NH_3 cannot be classified as a base by:
   a) Lewis theory b) Bronsted- Lowry theory
   b) Arrhenius theory d) Dalton theory
2. Acetic acid is used for:
   a) Flavoring food b) Making explosives
   c) Etching designs d) Cleaning metals
3. A reaction between an acid and a base produces:
   a) Salt and gas b) Salt and water
   c) Salt and an acid d) Salt and a base
4. The word acid is derived from the:
   a) English word b) Arabic word
   c) Greek word d) Latin word
5. Which acid is present in our stomach?
   a) Nitric acid b) Hydrochloric acid
   c) Sulphuric acid d) Acetic acid
6. A substance which can behave as an acid as well as a base is called:
   a) Acid b) Base
   c) Amphoteric specie d) Neutral specie
7. Which one is not an Arrhenius base?
   a) NaOH b) KOH
   c) $Ca(OH)_2$ d) NH_3
8. The optimum PH range of a swimming pool is:
   a) 7 to 7.6 b) 7.1 to 7.6
   c) 7.2 to 7.6 d) 7.3 to 7.6
9. Acids used in printing industries is:
   a) HCl b) H_2SO_4
   c) HNO_3 d) CH_3COOH
10. Which of the following does not have PH value greater than 7:
    a) Shampoo b) Detergents
    c) Butter d) Soap
11. Potato plants grow well at PH range?
    a) 5.2 to 6.5 b) 5.3 to 6.5
    c) 5.4 to 6.5 d) 5.5 to 6.5
12. PH of water is:
    a) 6 b) 7
    c) 8 d) 9

13. Lactic acid is found in:
    a) Citrus fruit
    b) Sour milk
    c) Butter
    d) Apple
14. Phenolphthalein produces pink colour in:
    a) Acid
    b) Base
    c) Both (a) & (b)
    d) Water
15. Which of the following is a much more reliable and accurate method of measuring pH of a solution:
    a) Litmus paper
    b) Universal indicator
    c) PH meter
    d) Taste with tongue
16. PH of 0.01M H_2SO_4 solution is:
    a) 10
    b) 2
    c) 1.7
    d) 0.3
17. Which of the following is not a basic salt:
    a) $Al(OH)_2Cl$
    b) NaH_2PO_4
    c) $Pb(OH)CH_3COO$
    d) $Zn(OH)NO_3$
18. Which one is not the characteristic of an acid?
    a) Turns blue litmus red
    b) Corrosive in nature
    c) Have sour taste
    d) Have bitter taste
19. Acids react explosively with metals:
    a) Sodium, calcium
    b) Magnesium, zinc
    c) Aluminium, iron
    d) Iron, sodium
20. Acid is a substance which dissociates in aqueous solution to give hydrogen ions:
    a) Bronsted-Lowry concept
    b) Lewis Acid concept
    c) Arrhenius concept
    d) Humphrey concept
21. According to Lewis, a base is a substance which donate:
    a) Proton
    b) Neutron
    c) Pair of electrons
    d) Hydroxyl ions
22. Acids react with bases to form salts and water. This process is called:
    a) Sublimation
    b) Filtration
    c) Ignition
    d) Neutralization
23. The base used to neutralize acidity in the stomach and for treatment of bee's stings:
    a) Aluminium hydroxide
    b) Magnesium hydroxide
    c) Ammonium hydroxide
    d) Potassium hydroxide
24. PH + POH =?
    a) 10
    b) 12
    c) 14
    d) 16
25. It is a common indicator:
    a) Litmus paper
    b) Phenolphthalein
    c) Bromine
    d) Ethene
26. In strongly alkaline solution the colour of phenolphthalein is:
    a) Pink
    b) Red
    c) Green
    d) Yellow

27. Organic compounds having different colours in acidic and alkaline solutions are called?
    a) Alkalies
    b) Acids
    c) Salts
    d) Indicators
28. Ionic compounds generally formed by the neutralization of an acid with base are called:
    a) Complexes
    b) Salts
    c) Powder
    d) Crystals
29. Soda lime is mixture of:
    a) CaO and NaOH
    b) $Ca(OH)_2$ and CaO
    c) $Ca(OH)_2$ and NaOH
    d) $CaSO_4$ and H_2O
30. Incomplete neutralization of a polyhydroxy base by an acid form:
    a) Double salt
    b) Basic salt
    c) Mixed salt
    d) Complex salt
31. Formula of caustic soda is:
    a) Na_2SO_4
    b) NaOH
    c) Na_2CO_3
    d) NaCl
32. Chemicals used to prevent food spoilage are called:
    a) Preservative
    b) Medicines
    c) Anti-oxidant
    d) Expensive chemicals
33. It is called table salt:
    a) Sodium carbonate
    b) Sodium sulphate
    c) Sodium chloride
    d) Sodium chlorate
34. About 99% atmosphere's mass lies within:
    a) 20 kilometre
    b) 30 kilometre
    c) 40 kilometre
    d) 50 kilometre
35. Just above the Earth's surface is:
    a) Mesosphere
    b) Stratosphere
    c) Thermosphere
    d) Troposphere
36. Normally rain water is weakly acidic because of:
    a) SO_3 gas
    b) CO_2 gas
    c) SO_2 gas
    d) NO_2 gas
37. Acid rain affects the aquatic life by clogging fish gills because of:
    a) Lead metal
    b) Chromium metal
    c) Mercury metal
    d) Aluminium metal
38. Ozone is beneficial for us as it:
    a) Absorbs infrared radiations
    b) Absorbs chlorofluorocarbons
    c) Absorbs ultraviolet radiations
    d) Absorbs air pollutants
39. Iron and steel structures are damaged by:
    a) Carbon monoxide
    b) Carbon dioxide
    c) Methane
    d) Sulphur dioxide
40. Effects of ozone depletion are following except the one:
    a) Increases infectious diseases
    b) Increases crops production
    c) Can cause skin cancer
    d) Can cause climatic changes
41. Which one of these pollutants is not found in car exhaust fumes?
    a) O_3
    b) CO
    c) NO_2
    d) SO_2

42. The envelope of different gases around the Earth is:
    a) Surroundings b) Environment
    c) Atmosphere d) Pollution
43. Percentage of Argon by volume in atmosphere is:
    a) 0.83% b) 0.93%
    c) 0.103% d) 0.113%
44. Solar energy radiated as heat energy of longer wavelength is absorbed by:
    a) Water vapours and CO_2 in atmosphere b) Water and carbon monoxide
    c) Gas particles and NO_2 in atmosphere d) Solid particles and SO_2 in air
45. Stratosphere extends up to:
    a) 40km b) 50km
    c) 60km d) 70km
46. Depending upon the temperature variation, atmosphere is divided into:
    a) Two regions b) Three regions
    c) Four regions d) Five regions
47. What is the height of thermosphere above the Earth's surface?
    a) 0-12km b) 12-50km
    c) 50-85km d) Beyond 85km
48. The major constituents of troposphere are:
    a) Carbon and carbon dioxide b) Nitrogen and nitrogen dioxide
    c) Nitrogen and oxygen d) Nitrogen and argon
49. Carbon dioxide and water vapours absorbs much of the outgoing radiations and:
    a) Cool the atmosphere b) Warm the atmosphere
    c) Destroy the atmosphere d) Make pleasant atmosphere
50. Major air pollutants are classified as:
    a) Primary and secondary b) Secondary and tertiary
    c) Primary, secondary and tertiary d) Artificial and manmade
51. Plants consume CO_2 in photosynthesis process and produce:
    a) CO b) O_2
    c) Cl_2 d) O_3
52. CO_2 in the atmosphere acts like a glass wall of a greenhouse and it traps some of the:
    a) Ultraviolet radiations b) Infrared radiations
    c) Electromagnetic radiations d) Vibrating radiations
53. The increased concentration of CO_2, due to human activities results in trapping of heat causes:
    a) Greenhouse effect b) Acidic rain
    c) Blue house effect d) Black house effect
54. When carbon monoxide is inhaled, it binds with the haemoglobin most strongly than that of oxygen, thus hindering the supply of:
    a) Nitrogen in body b) Carbon dioxide in body
    c) Oxygen in body d) Calcium in body
55. Naturally occurring sulphur containing compounds are emitted in:
    a) Emitted by the Earth b) Bio-Diesel
    c) Forest fires d) Natural rain

56. How much of the total SO_2 is released by the combustion of coal and petroleum products?
    a) About 40%
    b) About 60%
    c) About 80%
    d) About 100%
57. Without a healthy environment, there will be no healthy:
    a) Human
    b) Plant
    c) Animal
    d) Human, plant and animal
58. The pH of the acidic rain is about:
    a) 3.6 to 4
    b) 4.6 to 5
    c) 5.6 to 6
    d) 6.6 to 7
59. Rain water converts:
    a) SO_2 into SO_3
    b) SO_3 into SO_4
    c) H_2SO_3 into H_2SO_4
    d) SO_2 into H_2SO_4
60. Ozone is an allotropic form of oxygen consisting of:
    a) Two oxygen atoms
    b) Three oxygen atoms
    c) Four oxygen atoms
    d) Five oxygen atoms
61. Acid rain attacks the calcium carbonate present in the marble and limestone of buildings and monuments and these buildings are getting:
    a) Beautiful
    b) Strong
    c) More durable
    d) Dull and eroded day by day
62. Ozone is formed in atmosphere by the association of an oxygen atom with an oxygen molecule in the mid of:
    a) Troposphere
    b) Mesosphere
    c) Stratosphere
    d) Thermosphere
63. The compound which is responsible for the depletion of ozone layer:
    a) Chlorofluorocarbons
    b) Methane
    c) Carbon dioxide
    d) Nitrogen dioxide
64. Signs of ozone depletion were first noticed over:
    a) Pakistan in 1980s
    b) India in 1980s
    c) Antarctica in 1980s
    d) America in 1980s
65. Incineration of waste material causes:
    a) Air pollution
    b) Water pollution
    c) Soil pollution
    d) Sound pollution
66. Incinerators reduce the solid mass of the original waste by:
    a) 50 – 55%
    b) 60 – 65%
    c) 70 – 75%
    d) 80 – 85%
67. Which one of the following property of water is responsible for rising of water in plants?
    a) Specific heat capacity
    b) Surface tension
    c) Excellent solvent action
    d) Capillary action
68. Water dissolves non-ionic compound by:
    a) Ion-ion forces
    b) Ion-dipole forces
    c) Dipole-dipole forces
    d) Hydrogen bonding
69. Temporary hardness of water is removed by adding:
    a) Slaked lime
    b) Quick lime
    c) Lime stone
    d) Lime water

70. Which of the following salt makes the water permanently hard?
a) Na_2CO_3 b) $NaHCO_3$
c) $CaSO_4$ d) $Ca(HCO_3)_2$

71. Which of the following disease causes liver inflammation?
a) Hepatitis b) Typhoid
c) Jaundice d) Cholera

72. A disease that causes bone and tooth damage is:
a) Cholera b) Fluorosis
c) Hepatitis d) Jaundice

73. Human body consists of about:
a) 50% water b) 60% water
c) 70% water d) 80% water

74. How much percentage of the total water on the Earth is fit for drinking purpose?
a) Only 0.1% b) Only 0.2%
c) Only 0.3% d) Only 0.4%

75. Which is not a property of water?
a) It turns red litmus to blue b) It is neutral to litmus
c) Its freezing point is 0°C d) Its boiling point is 100°C at sea level

76. Water has high surface tension, this unique property of water is responsible for its:
a) Moderate capillary action b) Low capillary action
c) Higher capillary action d) Zero capillary action

77. Water molecule has a:
a) Polar structure b) Non polar structure
c) Sometime polar and sometime non polar d) Half polar and half non polar

78. Which is not an example of non-polar compound?
a) Benzene b) Ether
c) Octane d) Sodium chloride

79. The water which produces good lather with soap is called:
a) Dirty water b) Heavy water
c) Soft water d) Hard water

80. Hard water may dissolve chlorides and sulphates of:
a) Iron and aluminium b) Calcium and magnesium
c) Gallium and sodium d) Potassium and rubidium

81. The molecular formula of gypsum is:
a) $CaSO_4.2H_2O$ b) $CaSO_4.3H_2O$
c) $CaSO_4.4H_2O$ d) $CaSO_4.5H_2O$

82. The removal of Mg^{+2} and Ca^{+2} ions which are responsible for the hardness is called:
a) Water deficiency b) Water excess
c) Water softening d) Water hardening

83. Temporary hardness of water is easily removed by:
a) Clark's method b) Boiling water
c) Boyle's method d) Ion exchange method

84. Sodium zeolite is a naturally occurring resin of:
a) Lithium aluminium silicate b) Calcium aluminium silicate
c) Magnesium aluminium silicate d) Sodium aluminium silicate

85. Soap is the sodium salt of a:
a) Long chain alcoholic compounds b) Small chain ketone compound
c) Long chain carboxylic acid d) Long chain ketone compound

86. In the process of scum formation:
a) Less soap is produced b) Large soap is produced
c) Less soap is wasted d) Large soap is wasted

87. Dysfunction of kidney, liver, brain, central nervous system and reproductive system is caused by:
a) Acute cadmium poisoning b) Mercury poisoning
c) Acute lead poisoning d) Cobalt poisoning

88. Which heavy metal is toxic and health hazard for human beings?
a) Cadmium b) Lead
c) Mercury d) Cadmium, lead and mercury

89. Use of detergents is increasing day by day for cleaning purpose in:
a) House and industries b) Fish forms
c) Poultry forms d) Fish, poultry and dairy forms

90. Detergents have a major disadvantage over the soaps as some of detergents are:
a) Biodegradable b) Non-biodegradable
c) Rechargeable d) Non-rechargeable

91. Domestic sewage contains a wide variety of:
a) Dissolved impurities b) Suspended impurities
c) Dissolved and suspended impurities d) Lead impurities

92. Pesticides are used either directly to kill or control:
a) Growth of birds b) Growth of mammals
c) Growth of amphibians d) Growth of pests

93. Which do protect teeth from decay?
a) Compounds of chlorine b) Compounds of bromine
c) Compounds of fluorine d) Compounds of iodine

94. The water contains nitrate and phosphate salts results in a:
a) Slow growth of algae b) Rapid growth of algae
c) Slow growth of fungi d) Rapid growth of fungus

95. Diseases that spread because of drinking polluted water or eating food prepared with polluted water are called:
a) Waterborne diseases b) Airborne diseases
c) Soil borne diseases d) Vapour borne diseases

96. Intestinal disease such as cholera can cause:
a) Mild dehydration b) Dangerous dehydration
c) Mild dropsy d) Dangerous dropsy

97. The process involving boiling of a liquid and then condensing the vapours is called:
a) Filtration b) Decomposition
c) Distillation d) Disinfection

98. A dangerous bacterial disease often spread by contaminated water or by food prepared with contaminated water is called:
    a) Cryptosporidium
    b) Fluorosis
    c) Jaundice
    d) Typhoid
99. Hookworm is a parasitic worm that infects:
    a) Small intestine
    b) Large intestine
    c) Stomach
    d) Liver
100. Cholera is an acute infection caused by:
    a) Protozoa
    b) Virus
    c) Bacteria
    d) Fungi

Appendix 4

Post-Test

Name: …… Time allowed: 100 minutes Class: 10th

Roll No: …… Group: …… Marks: 100

Note: Encircle the correct option. Overwriting is not allowed.

1. Which of the following is a much more reliable and accurate method of measuring pH of a solution:
   a) PH meter b) Universal indicator
   c) Litmus paper d) Taste with tongue
2. Which of the following is not a basic salt:
   a) $Al(OH)_2Cl$ b) NaH_2PO_4
   c) $Pb(OH)CH_3COO$ d) $Zn(OH)NO_3$
3. PH of 0.01M H_2SO_4 solution is:
   a) 10 b) 2
   c) 1.7 d) 0.3
4. Which one is not the characteristic of an acid?
   a) Turns blue litmus red b) Corrosive in nature
   c) Have sour taste d) Have bitter taste
5. Acetic acid is used for:
   a) Flavoring food b) Making explosives
   c) Etching designs d) Cleaning metals
6. Acid is a substance which dissociates in aqueous solution to give hydrogen ions:
   a) Arrhenius concept b) Lewis Acid concept
   c) Bronsted-Lowry concept d) Humphrey concept
7. NH_3 cannot be classified as a base by:
   a) Lewis theory b) Bronsted- Lowry theory
   c) Arrhenius theory d) Dalton theory
8. Acids react explosively with metals:
   a) Sodium, calcium b) Magnesium, zinc
   c) Aluminium, iron d) Iron, sodium
9. Acids react with bases to form salts and water. This process is called:
   a) Sublimation b) Filtration
   c) Ignition d) Neutralization
10. According to Lewis, a base is a substance which donate:
    a) Pair of electrons b) Proton
    c) Neutron d) Hydroxyl ions
11. In strongly alkaline solution the colour of phenolphthalein is:
    a) Pink b) Red
    c) Green d) Yellow
12. A reaction between an acid and a base produces:
    a) Salt and gas b) Salt and water
    c) Salt and an acid d) Salt and a base

13. PH + POH =?
    a) 10 b) 12
    c) 14 d) 16
14. The base used to neutralize acidity in the stomach and for treatment of bee's stings:
    a) Aluminium hydroxide b) Magnesium hydroxide
    c) Ammonium hydroxide d) Potassium hydroxide
15. The word acid is derived from the:
    a) English word b) Arabic word
    c) Greek word d) Latin word
16. It is called table salt:
    a) Sodium carbonate b) Sodium sulphate
    c) Sodium chloride d) Sodium chlorate
17. Which acid is present in our stomach?
    a) Nitric acid b) Sulphuric acid
    c) Hydrochloric acid d) Acetic acid
18. In strongly alkaline solution the colour of phenolphthalein is:
    a) Pink b) Red
    c) Green d) Yellow
19. Organic compounds having different colours in acidic and alkaline solutions are called?
    a) Alkalies b) Acids
    c) Salts d) Indicators
20. A substance which can behave as an acid as well as a base is called:
    a) Acid b) Base
    c) Amphoteric specie d) Neutral specie
21. Chemicals used to prevent food spoilage are called:
    a) Preservative b) Medicines
    c) Anti-oxidant d) Expensive chemicals
22. Formula of caustic soda is:
    a) Na_2SO_4 b) Na_2CO_3
    c) NaOH d) NaCl
23. Which one is not an Arrhenius base?
    a) NaOH b) KOH
    c) $Ca(OH)_2$ d) NH_3
24. The optimum PH range of a swimming pool is:
    a) 7 to 7.6 b) 7.1 to 7.6
    c) 7.2 to 7.6 d) 7.3 to 7.6
25. Ionic compounds generally formed by the neutralization of an acid with base are called:
    a) Complexes b) Salts
    c) Powder d) Crystals
26. Acids used in printing industries is:
    a) HCl b) H_2SO_4
    c) HNO_3 d) CH_3COOH

27. Which of the following does not have PH value greater than 7:
    a) Shampoo
    b) Detergents
    c) Butter
    d) Soap
28. Soda lime is mixture of:
    a) CaO and NaOH
    b) $Ca(OH)_2$ and CaO
    c) $Ca(OH)_2$ and NaOH
    d) $CaSO_4$ and H_2O
29. Potato plants grow well at PH range?
    a) 5.2 to 6.5
    b) 5.3 to 6.5
    c) 5.4 to 6.5
    d) 5.5 to 6.5
30. Phenolphthalein produces pink colour in:
    a) Acid
    b) Base
    c) Both (a) & (b)
    d) Water
31. PH of water is:
    a) 6
    b) 7
    c) 8
    d) 9
32. Lactic acid is found in:
    a) Citrus fruit
    b) Butter
    c) Sour milk
    d) Apple
33. Incomplete neutralization of a polyhydroxy base by an acid form:
    a) Double salt
    b) Basic salt
    c) Mixed salt
    d) Complex salt
34. Percentage of Argon by volume in atmosphere is:
    a) 0.83%
    b) 0.93%
    c) 0.103%
    d) 0.113%
35. Solar energy radiated as heat energy of longer wavelength is absorbed by:
    a) Water vapours and CO_2 in atmosphere b) Water and carbon monoxide
    c) Gas particles and NO_2 in atmosphere d) Solid particles and SO_2 in air
36. CO_2 in the atmosphere acts like a glass wall of a greenhouse and it traps some of the:
    a) Ultraviolet radiations
    b) Infrared radiations
    c) Electromagnetic radiations
    d) Vibrating radiations
37. The envelope of different gases around the Earth is:
    a) Surroundings
    b) Environment
    c) Atmosphere
    d) Pollution
38. The pH of the acidic rain is about:
    a) 3.6 to 4
    b) 4.6 to 5
    c) 5.6 to 6
    d) 6.6 to 7
39. Which one of these pollutants is not found in car exhaust fumes?
    a) O_3
    b) CO
    c) NO_2
    d) SO_2
40. Ozone is an allotropic form of oxygen consisting of:
    a) Two oxygen atoms
    b) Three oxygen atoms
    c) Four oxygen atoms
    d) Five oxygen atoms

41. Effects of ozone depletion are following except the one:
    a) Increases infectious diseases
    b) Increases crops production
    c) Can cause skin cancer
    d) Can cause climatic changes

42. Ozone is formed in atmosphere by the association of an oxygen atom with an oxygen molecule in the mid of:
    a) Troposphere b) Mesosphere
    c) Stratosphere d) Thermosphere
43. Iron and steel structures are damaged by:
    a) Carbon monoxide b) Carbon dioxide
    c) Methane d) Sulphur dioxide
44. Stratosphere extends up to:
    a) 40km b) 50km
    c) 60km d) 70km
45. Incineration of waste material causes:
    a) Air pollution b) Water pollution
    c) Soil pollution d) Sound pollution
46. Ozone is beneficial for us as it:
    a) Absorbs infrared radiations b) Absorbs chlorofluorocarbons
    c) Absorbs ultraviolet radiations d) Absorbs air pollutants
47. Depending upon the temperature variation, atmosphere is divided into:
    a) Two regions b) Three regions
    c) Four regions d) Five regions
48. Acid rain affects the aquatic life by clogging fish gills because of:
    a) Lead metal b) Chromium metal
    c) Mercury metal d) Aluminium metal
49. Without a healthy environment, there will be no healthy:
    a) Human b) Plant
    c) Animal d) Human, plant and animal
50. Incinerators reduce the solid mass of the original waste by
    a) 50 – 55% b) 60 – 65%
    c) 70 – 75% d) 80 – 85%
51. What is the height of thermosphere above the Earth's surface?
    a) 0-12km b) 12-50km
    c) 50-85km d) Beyond 85km
52. The major constituents of troposphere are:
    a) Carbon and carbon dioxide b) Nitrogen and nitrogen dioxide
    c) Nitrogen and oxygen d) Nitrogen and argon
53. Just above the Earth's surface is:
    a) Mesosphere b) Stratosphere
    c) Thermosphere d) Troposphere
54. Normally rain water is weakly acidic because of:
    a) SO_3 gas b) CO_2 gas
    c) SO_2 gas d) NO_2 gas
55. Signs of ozone depletion were first noticed over:
    a) Pakistan in 1980s b) India in 1980s
    c) Antarctica in 1980s d) America in 1980s
56. Carbon dioxide and water vapours absorbs much of the outgoing radiations and:
    a) Cool the atmosphere b) Warm the atmosphere
    c) Destroy the atmosphere d) Make pleasant atmosphere

57. About 99% atmosphere's mass lies within:
    a) 20 kilometre
    b) 30 kilometre
    c) 40 kilometre
    d) 50 kilometre
58. Rain water converts:
    a) SO_2 into SO_3
    b) SO_3 into SO_4
    c) H_2SO_3 into H_2SO_4
    d) SO_2 into H_2SO_4
59. Major air pollutants are classified as:
    a) Primary and secondary
    b) Secondary and tertiary
    c) Primary, secondary and tertiary
    d) Artificial and manmade
60. The increased concentration of CO_2, due to human activities results in trapping of heat causes:
    a) Greenhouse effect
    b) Acidic rain
    c) Blue house effect
    d) Black house effect
61. Plants consume CO_2 in photosynthesis process and produce:
    a) CO
    b) Cl_2
    c) O_2
    d) O_3
62. Naturally occurring sulphur containing compounds are emitted in:
    a) Forest fires
    b) Emitted by the Earth
    c) Bio-Diesel
    d) Natural rain
63. Acid rain attacks the calcium carbonate present in the marble and limestone of buildings and monuments and these buildings are getting:
    a) Beautiful
    b) Strong
    c) More durable
    d) Dull and eroded day by day
64. The compound which is responsible for the depletion of ozone layer:
    a) Chlorofluorocarbons
    b) Methane
    c) Carbon dioxide
    d) Nitrogen dioxide
65. How much of the total SO_2 is released by the combustion of coal and petroleum products?
    a) About 40%
    b) About 60%
    c) About 80%
    d) About 100%
66. When carbon monoxide is inhaled, it binds with the haemoglobin most strongly than that of oxygen, thus hindering the supply of:
    a) Nitrogen in body
    b) Carbon dioxide in body
    c) Oxygen in body
    d) Calcium in body
67. Which is not a property of water?
    a) It turns red litmus to blue
    b) It is neutral to litmus
    c) Its freezing point is 0°C
    d) Its boiling point is 100°C at sea level
68. Dysfunction of kidney, liver, brain, central nervous system and reproductive system is caused by:
    a) Acute cadmium poisoning
    b) Mercury poisoning
    c) Acute lead poisoning
    d) Cobalt poisoning
69. Water has high surface tension, this unique property of water is responsible for its:
    a) Low capillary action
    b) Moderate capillary action
    c) Higher capillary action
    d) Zero capillary action

70. Pesticides are used either directly to kill or control:
    a) Growth of birds
    b) Growth of mammals
    c) Growth of amphibians
    d) Growth of pests
71. Which heavy metal is toxic and health hazard for human beings?
    a) Cadmium
    b) Lead
    c) Mercury
    d) Cadmium, lead and mercury
72. The water contains nitrate and phosphate salts results in a:
    a) Slow growth of algae
    b) Rapid growth of algae
    c) Slow growth of fungi
    d) Rapid growth of fungi
73. How much percentage of the total water on the Earth is fit for drinking purpose?
    a) Only 0.1%
    b) Only 0.2%
    c) Only 0.3%
    d) Only 0.4%
74. Which do protect teeth from decay?
    a) Compounds of chlorine
    b) Compounds of bromine
    c) Compounds of fluorine
    d) Compounds of iodine
75. Human body consists of about:
    a) 50% water
    b) 60% water
    c) 70% water
    d) 80% water
76. In the process of scum formation:
    a) Less soap is wasted
    b) Large soap is wasted
    c) Less soap is produced
    d) Large soap is produced
77. Cholera is an acute infection caused by:
    a) Protozoa
    b) Virus
    c) Bacteria
    d) Fungi
78. Hookworm is a parasitic worm that infects:
    a) Small intestine
    b) Large intestine
    c) Stomach
    d) Liver
79. Temporary hardness of water is removed by adding:
    a) Slaked lime
    b) Quick lime
    c) Lime stone
    d) Lime water
80. A dangerous bacterial disease often spread by contaminated water or by food prepared with contaminated water is called:
    a) Cryptosporidium
    b) Fluorosis
    c) Jaundice
    d) Typhoid
81. The process involving boiling of a liquid and then condensing the vapours is called:
    a) Filtration
    b) Decomposition
    c) Distillation
    d) Disinfection
82. Water dissolves non-ionic compound by:
    a) Ion-ion forces
    b) Ion-dipole forces
    c) Dipole-dipole forces
    d) Hydrogen bonding
83. Water molecule has a:
    a) Polar structure
    b) None polar structure
    c) Sometime polar and sometime non polar
    d) Half polar and half non polar

84. Which of the following salt makes the water permanently hard?
a) Na_2CO_3 b) $NaHCO_3$
c) $CaSO_4$ d) $Ca(HCO_3)_2$

85. A disease that causes bone and tooth damage is:
a) Cholera b) Fluorosis
c) Hepatitis d) Jaundice

86. Temporary hardness of water is easily removed by:
a) Clark's method b) Boiling water
c) Boyle's method d) Ion exchange method

87. Use of detergents is increasing day by day for cleaning purpose in:
a) House and industries b) Fish forms
c) Poultry forms d) Fish, poultry and dairy forms

88. Which of the following disease causes liver inflammation?
a) Hepatitis b) Typhoid
c) Jaundice d) Cholera

89. The removal of Mg^{+2} and Ca^{+2} ions which are responsible for the hardness is called:
a) Water deficiency b) Water excess
c) Water softening d) Water hardening

90. Soap is the sodium salt of a:
a) Long chain alcoholic compounds b) Long chain carboxylic acid
c) Small chain ketone compound d) Long chain ketone compound

91. Sodium zeolite is a naturally occurring resin of:
a) Lithium aluminium silicate b) Magnesium aluminium silicate
c) Calcium aluminium silicate d) Sodium aluminium silicate

92. Domestic sewage contains a wide variety of:
a) Dissolved impurities b) Suspended impurities
c) Dissolved and suspended impurities d) Lead impurities

93. Which one of the following property of water is responsible for rising of water in plants?
a) Specific heat capacity b) Surface tension
c) Excellent solvent action d) Capillary action

94. Detergents have a major disadvantage over the soaps as some of detergents are:
a) Biodegradable b) Non-biodegradable
c) Rechargeable d) Non-rechargeable

95. Intestinal disease such as cholera can cause:
a) Mild dehydration b) Dangerous dehydration
c) Mild dropsy d) Dangerous dropsy

96. Diseases that spread because of drinking polluted water or eating food prepared with polluted water are called:
a) Waterborne infectious diseases b) Airborne infectious diseases
c) Soil borne infectious diseases d) Vapour borne infectious diseases

97. Which is not an example of non-polar compound?
a) Benzene b) Ether
c) Octane d) Sodium chloride

98. Hard water may dissolve chlorides and sulphates of:
    a) Iron and aluminium
    b) Calcium and magnesium
    c) Gallium and sodium
    d) Potassium and rubidium
99. The molecular formula of gypsum is:
    a) $CaSO_4.2H_2O$
    b) $CaSO_4.3H_2O$
    c) $CaSO_4.4H_2O$
    d) $CaSO_4.5H_2O$
100. The water which produces good lather with soap is called:
    a) Dirty water
    b) Heavy water
    c) Soft water
    d) Hard water

Appendix 5

Retention-Test

Name: …… Time allowed: 100 minutes Class: 10th

Roll No: …… Group: …… Marks: 100

Note: Encircle the correct option. Overwriting is not allowed.

1. Which of the following is a much more reliable and accurate method of measuring pH of a solution:
   a) PH meter b) Universal indicator
   c) Litmus paper d) Taste with tongue
2. Which of the following is not a basic salt:
   a) $Al(OH)_2Cl$ b) NaH_2PO_4
   c) $Pb(OH)CH_3COO$ d) $Zn(OH)NO_3$
3. PH of 0.01M H_2SO_4 solution is:
   a) 10 b) 2
   c) 1.7 d) 0.3
4. Which one is not the characteristic of an acid?
   a) Turns blue litmus red b) Corrosive in nature
   c) Have sour taste d) Have bitter taste
5. Acetic acid is used for:
   a) Flavoring food b) Making explosives
   c) Etching designs d) Cleaning metals
6. Acid is a substance which dissociates in aqueous solution to give hydrogen ions:
   a) Arrhenius concept b) Lewis Acid concept
   c) Bronsted-Lowry concept d) Humphrey concept
7. NH_3 cannot be classified as a base by:
   a) Lewis theory b) Bronsted- Lowry theory
   d) Arrhenius theory d) Dalton theory
8. Acids react explosively with metals:
   a) Sodium, calcium b) Magnesium, zinc
   c) Aluminium, iron d) Iron, sodium
9. Acids react with bases to form salts and water. This process is called:
   a) Sublimation b) Filtration
   c) Ignition d) Neutralization
10. According to Lewis, a base is a substance which donate:
    a) Pair of electrons b) Proton
    c) Neutron d) Hydroxyl ions
11. In strongly alkaline solution the colour of phenolphthalein is:
    a) Pink b) Red
    c) Green d) Yellow
12. A reaction between an acid and a base produces:
    a) Salt and gas b) Salt and water
    c) Salt and an acid d) Salt and a base

13. PH + POH =?
    a) 10 b) 12
    c) 14 d) 16
14. The base used to neutralize acidity in the stomach and for treatment of bee's stings:
    a) Aluminium hydroxide b) Magnesium hydroxide
    c) Ammonium hydroxide d) Potassium hydroxide
15. The word acid is derived from the:
    a) English word b) Arabic word
    c) Greek word d) Latin word
16. It is called table salt:
    a) Sodium carbonate b) Sodium sulphate
    c) Sodium chloride d) Sodium chlorate
17. Which acid is present in our stomach?
    a) Nitric acid b) Sulphuric acid
    c) Hydrochloric acid d) Acetic acid
18. In strongly alkaline solution the colour of phenolphthalein is:
    a) Pink b) Red
    c) Green d) Yellow
19. Organic compounds having different colours in acidic and alkaline solutions are called?
    a) Alkalies b) Acids
    c) Salts d) Indicators
20. A substance which can behave as an acid as well as a base is called:
    a) Acid b) Base
    c) Amphoteric specie d) Neutral specie
21. Chemicals used to prevent food spoilage are called:
    a) Preservative b) Medicines
    c) Anti-oxidant d) Expensive chemicals
22. Formula of caustic soda is:
    a) Na_2SO_4 b) Na_2CO_3
    c) NaOH d) NaCl
23. Which one is not an Arrhenius base?
    a) NaOH b) KOH
    c) $Ca(OH)_2$ d) NH_3
24. The optimum PH range of a swimming pool is:
    a) 7 to 7.6 b) 7.1 to 7.6
    c) 7.2 to 7.6 d) 7.3 to 7.6
25. Ionic compounds generally formed by the neutralization of an acid with base are called:
    a) Complexes b) Salts
    c) Powder d) Crystals
26. Acids used in printing industries is:
    a) HCl b) H_2SO_4
    c) HNO_3 d) CH_3COOH

27. Which of the following does not have PH value greater than 7:
    a) Shampoo b) Detergents
    c) Butter d) Soap
28. Soda lime is mixture of:
    a) CaO and NaOH b) $Ca(OH)_2$ and CaO
    c) $Ca(OH)_2$ and NaOH d) $CaSO_4$ and H_2O
29. Potato plants grow well at PH range?
    a) 5.2 to 6.5 b) 5.3 to 6.5
    c) 5.4 to 6.5 d) 5.5 to 6.5
30. Phenolphthalein produces pink colour in:
    a) Acid b) Base
    c) Both (a) & (b) d) Water
31. PH of water is:
    a) 6 b) 7
    c) 8 d) 9
32. Lactic acid is found in:
    a) Citrus fruit b) Butter
    c) Sour milk d) Apple
33. Incomplete neutralization of a polyhydroxy base by an acid form:
    a) Double salt b) Basic salt
    c) Mixed salt d) Complex salt
34. Percentage of Argon by volume in atmosphere is:
    a) 0.83% b) 0.93%
    c) 0.103% d) 0.113%
35. Solar energy radiated as heat energy of longer wavelength is absorbed by:
    a) Water vapours and CO_2 in atmosphere b) Water and carbon monoxide
    c) Gas particles and NO_2 in atmosphere d) Solid particles and SO_2 in air
36. CO_2 in the atmosphere acts like a glass wall of a greenhouse and it traps some of the:
    a) Ultraviolet radiations b) Infrared radiations
    c) Electromagnetic radiations d) Vibrating radiations
37. The envelope of different gases around the Earth is:
    a) Surroundings b) Environment
    c) Atmosphere d) Pollution
38. The pH of the acidic rain is about:
    a) 3.6 to 4 b) 4.6 to 5
    c) 5.6 to 6 d) 6.6 to 7
39. Which one of these pollutants is not found in car exhaust fumes?
    a) O_3 b) CO
    c) NO_2 d) SO_2
40. Ozone is an allotropic form of oxygen consisting of:
    a) Two oxygen atoms b) Three oxygen atoms
    c) Four oxygen atoms d) Five oxygen atoms
41. Effects of ozone depletion are following except the one:
    a) Increases infectious diseases b) Increases crops production
    c) Can cause skin cancer d) Can cause climatic changes

42. Ozone is formed in atmosphere by the association of an oxygen atom with an oxygen molecule in the mid of:
    a) Troposphere b) Mesosphere
    c) Stratosphere d) Thermosphere
43. Iron and steel structures are damaged by:
    a) Carbon monoxide b) Carbon dioxide
    c) Methane d) Sulphur dioxide
44. Stratosphere extends up to:
    a) 40km b) 50km
    c) 60km d) 70km
45. Incineration of waste material causes:
    b) Air pollution b) Water pollution
    c) Soil pollution d) Sound pollution
46. Ozone is beneficial for us as it:
    a) Absorbs infrared radiations b) Absorbs chlorofluorocarbons
    c) Absorbs ultraviolet radiations d) Absorbs air pollutants
47. Depending upon the temperature variation, atmosphere is divided into:
    a) Two regions b) Three regions
    c) Four regions d) Five regions
48. Acid rain affects the aquatic life by clogging fish gills because of:
    a) Lead metal b) Chromium metal
    c) Mercury metal d) Aluminium metal
49. Without a healthy environment, there will be no healthy:
    a) Human b) Plant
    c) Animal d) Human, plant and animal
50. Incinerators reduce the solid mass of the original waste by:
    a) 50 – 55% b) 60 – 65%
    c) 70 – 75% d) 80 – 85%
51. What is the height of thermosphere above the Earth's surface?
    a) 0-12km b) 12-50km
    c) 50-85km d) Beyond 85km
52. The major constituents of troposphere are:
    a) Carbon and carbon dioxide b) Nitrogen and nitrogen dioxide
    c) Nitrogen and oxygen d) Nitrogen and argon
53. Just above the Earth's surface is:
    a) Mesosphere b) Stratosphere
    c) Thermosphere d) Troposphere
54. Normally rain water is weakly acidic because of:
    a) SO_3 gas b) CO_2 gas
    c) SO_2 gas d) NO_2 gas
55. Signs of ozone depletion were first noticed over:
    a) Pakistan in 1980s b) India in 1980s
    c) Antarctica in 1980s d) America in 1980s
56. Carbon dioxide and water vapours absorbs much of the outgoing radiations and:
    a) Cool the atmosphere b) Warm the atmosphere
    c) Destroy the atmosphere d) Make pleasant atmosphere

57. About 99% atmosphere's mass lies within:
    a) 20 kilometre
    b) 30 kilometre
    c) 40 kilometre
    d) 50 kilometre
58. Rain water converts:
    a) SO_2 into SO_3
    b) SO_3 into SO_4
    c) H_2SO_3 into H_2SO_4
    d) SO_2 into H_2SO_4
59. Major air pollutants are classified as:
    a) Primary and secondary
    b) Secondary and tertiary
    c) Primary, secondary and tertiary
    d) Artificial and manmade
60. The increased concentration of CO_2, due to human activities results in trapping of heat causes:
    a) Greenhouse effect
    b) Acidic rain
    c) Blue house effect
    d) Black house effect
61. Plants consume CO_2 in photosynthesis process and produce:
    a) CO
    b) Cl_2
    c) O_2
    d) O_3
62. Naturally occurring sulphur containing compounds are emitted in:
    a) Forest fires
    b) Emitted by the Earth
    c) Bio-Diesel
    d) Natural rain
63. Acid rain attacks the calcium carbonate present in the marble and limestone of buildings and monuments and these buildings are getting:
    a) Beautiful
    b) Strong
    c) More durable
    d) Dull and eroded day by day
64. The compound which is responsible for the depletion of ozone layer:
    a) Chlorofluorocarbons
    b) Methane
    c) Carbon dioxide
    d) Nitrogen dioxide
65. How much of the total SO_2 is released by the combustion of coal and petroleum products?
    a) About 40%
    b) About 60%
    c) About 80%
    d) About 100%
66. When carbon monoxide is inhaled, it binds with the haemoglobin most strongly than that of oxygen, thus hindering the supply of:
    a) Nitrogen in body
    b) Carbon dioxide in body
    c) Oxygen in body
    d) Calcium in body
67. Which is not a property of water?
    a) It turns red litmus to blue
    b) It is neutral to litmus
    c) Its freezing point is 0°C
    d) Its boiling point is 100°C at sea level
68. Dysfunction of kidney, liver, brain, central nervous system and reproductive system is caused by:
    a) Acute cadmium poisoning
    b) Mercury poisoning
    c) Acute lead poisoning
    d) Cobalt poisoning
69. Water has high surface tension, this unique property of water is responsible for its:
    a) Low capillary action
    b) Moderate capillary action
    c) Higher capillary action
    d) Zero capillary action

70. Pesticides are used either directly to kill or control:
    a) Growth of birds
    b) Growth of mammals
    c) Growth of amphibians
    d) Growth of pests
71. Which heavy metal is toxic and health hazard for human beings?
    a) Cadmium
    b) Lead
    c) Mercury
    d) Cadmium, lead and mercury
72. The water contains nitrate and phosphate salts results in a:
    a) Slow growth of algae
    b) Rapid growth of algae
    c) Slow growth of fungi
    d) Rapid growth of fungi
73. How much percentage of the total water on the Earth is fit for drinking purpose?
    a) Only 0.1%
    b) Only 0.2%
    c) Only 0.3%
    d) Only 0.4%
74. Which do protect teeth from decay?
    a) Compounds of chlorine
    b) Compounds of bromine
    c) Compounds of fluorine
    d) Compounds of iodine
75. Human body consists of about:
    a) 50% water
    b) 60% water
    c) 70% water
    d) 80% water
76. In the process of scum formation:
    a) Less soap is wasted
    b) Large soap is wasted
    c) Less soap is produced
    d) Large soap is produced
77. Cholera is an acute infection caused by:
    a) Protozoa
    b) Virus
    c) Bacteria
    d) Fungi
78. Hookworm is a parasitic worm that infects:
    a) Small intestine
    b) Large intestine
    c) Stomach
    d) Liver
79. Temporary hardness of water is removed by adding:
    a) Slaked lime
    b) Quick lime
    c) Lime stone
    d) Lime water
80. A dangerous bacterial disease often spread by contaminated water or by food prepared with contaminated water is called:
    a) Cryptosporidium
    b) Fluorosis
    c) Jaundice
    d) Typhoid
81. The process involving boiling of a liquid and then condensing the vapours is called:
    a) Filtration
    b) Decomposition
    c) Distillation
    d) Disinfection
82. Water dissolves non-ionic compound by:
    a) Ion-ion forces
    b) Ion-dipole forces
    c) Dipole-dipole forces
    d) Hydrogen bonding
83. Water molecule has a:
    a) Polar structure
    b) None polar structure
    c) Sometime polar and sometime non polar
    d) Half polar and half non polar

84. Which of the following salt makes the water permanently hard?
a) Na_2CO_3 b) $NaHCO_3$
c) $CaSO_4$ d) $Ca(HCO_3)_2$

85. A disease that causes bone and tooth damage is:
a) Cholera b) Fluorosis
c) Hepatitis d) Jaundice

86. Temporary hardness of water is easily removed by:
a) Clark's method b) Boiling water
c) Boyle's method d) Ion exchange method

87. Use of detergents is increasing day by day for cleaning purpose in:
a) House and industries b) Fish forms
c) Poultry forms d) Fish, poultry and dairy forms

88. Which of the following disease causes liver inflammation?
b) Hepatitis b) Typhoid
c) Jaundice d) Cholera

89. The removal of Mg^{+2} and Ca^{+2} ions which are responsible for the hardness is called:
a) Water deficiency b) Water excess
c) Water softening d) Water hardening

90. Soap is the sodium salt of a:
a) Long chain alcoholic compounds b) Long chain carboxylic acid
c) Small chain ketone compound d) Long chain ketone compound

91. Sodium zeolite is a naturally occurring resin of:
a) Lithium aluminium silicate b) Magnesium aluminium silicate
c) Calcium aluminium silicate d) Sodium aluminium silicate

92. Domestic sewage contains a wide variety of:
b) Dissolved impurities b) Suspended impurities
c) Dissolved and suspended impurities d) Lead impurities

93. Which one of the following property of water is responsible for rising of water in plants?
a) Specific heat capacity b) Surface tension
c) Excellent solvent action d) Capillary action

94. Detergents have a major disadvantage over the soaps as some of detergents are:
a) Biodegradable b) Non-biodegradable
c) Rechargeable d) Non-rechargeable

95. Intestinal disease such as cholera can cause:
a) Mild dehydration b) Dangerous dehydration
c) Mild dropsy d) Dangerous dropsy

96. Diseases that spread because of drinking polluted water or eating food prepared with polluted water are called:
a) Waterborne infectious diseases b) Airborne infectious diseases
c) Soil borne infectious diseases d) Vapour borne infectious diseases

97. Which is not an example of non-polar compound?
a) Benzene b) Ether
c) Octane d) Sodium chloride

98. Hard water may dissolve chlorides and sulphates of:
    a) Iron and aluminium
    b) Calcium and magnesium
    c) Gallium and sodium
    d) Potassium and rubidium
99. The molecular formula of gypsum is:
    a) $CaSO_4.2H_2O$
    b) $CaSO_4.3H_2O$
    c) $CaSO_4.4H_2O$
    d) $CaSO_4.5H_2O$
100. The water which produces good lather with soap is called:
    a) Dirty water
    b) Heavy water
    c) Soft water
    d) Hard water

Appendix 6

STATISTICAL DATA

PRE-TEST SCORE (Experimental Group)

S.No.	Names	Pre-Test Scores	S.No.	Names	Pre-Test Scores
1.	M. Khizar Hayat	51	21.	Saad Ahmad	37
2.	Mehmood-ul-Hassan	49	22.	Muhammad Awais Khan	36
3.	Saqib Khan	49	23.	Abdur Rehman	35
4.	Hasan Zaib	48	24.	Muhammad Ikram	35
5.	Muhammad Umar	47	25.	Naveed Gul	34
6.	M. Saqib Aziz	46	26.	Ubaid Ullah	32
7.	Awais Ahmed	46	27.	Usman Ghani	30
8.	Zubair Khan	45	28.	Abid Nawaz	29
9.	Farzand Ali	45	29.	Aitizaz Khan	29
10.	Saeed Khan	44	30.	Rab Nawaz	28
11.	Imran Shah	43	31.	Izhar Ahmed	27
12.	Shahzaib Khan	42	32.	Zeeshan	26
13.	Adnan	42	33.	Jawad Gul	25
14.	Muhammad Hamza	42	34.	Muzafar Shah	25
15.	Waqar	41	35.	Naseeb-ur-Rehman	24
16.	Jawad	41	36.	Hazrat Ali	23
17.	M. Adnan	40	37.	Wajid Hayat	22
18.	Aman	40	38.	Haris	20
19.	Bilal Ahmad	39	39.	Sangeen Khan	18
20.	Mehroz	38	40.	Muhammad Faisal	18

Appendix 7

STATISTICAL DATA

PRE-TEST SCORE (Control Group)

S.No.	Names	Pre-Test Scores	S.No.	Names	Pre-Test Scores
1.	Mohsin Raza	50	21.	Zeeshan Khan	37
2.	Waqas	49	22.	Mehdi Ali	36
3.	Mujeeb	49	23.	Ahmed Saeed	36
4.	Waqar Ali	48	24.	Noumanullah	35
5.	Irfan Mehmood	47	25.	Muhammad Waleed	34
6.	Muhammad Ali	46	26.	Abdul Rahim	33
7.	Yasir	46	27.	Ali Hasnain	30
8.	Aftab Khan	45	28.	Sarfraz Mughal	29
9.	Nouman Ali	45	29.	Jamal	29
10.	Zulfiqar Ali	44	30.	Aqib Ali	28
11.	Israr Shah	43	31.	Azhar Hussain	27
12.	Maqsood Ahmed	43	32.	Nasir Shah	26
13.	Athesham Shah	42	33.	Zohaib Khan	26
14.	Tayyab Nawaz	42	34.	Raja Umar	25
15.	Awais Abbasi	41	35.	Sher Zaman	24
16.	Mehtab Abbasi	41	36.	Muhammad Latif	23
17.	Muhammad Hafeez	40	37.	Nasir Mehmood	23
18.	Muharram Ali	40	38.	Hakim Khan	20
19.	Ahmed Ali	39	39.	Hamza Ali	19
20.	Waqas Hussain	38	40.	Ijaz Hussain	18

Appendix 8

Certificate for research tool validation

Certificate of validity

EFFECTS OF 5E'S INSTRUCTIONAL MODEL ON ACADEMIC ACHIEVEMENT IN 10th GRADE CHEMISTRY

Researcher: Irshad Hussain **Supervisor:** Dr. Azhar Mahmood

Registration No. 141-FSS/PHDEDU/F17 **Co-Supervisor:** Dr. Muhammad Munir Kayani

University: International Islamic University Islamabad

It is certified that the research tools used in the study by Mr. Irshad Hussain (Ph.D. Research Scholar) Entitled **"Effects of 5E's Instructional Model on Academic Achievement in 10th Grade Chemistry"** is assessed by me. I found it appropriate, reliable and valid for the process of data collection. Thus, the researcher is advised to use it for the data collection and analysis.

Name Dr. Shahid Iqbal Farooqi

Designation Assistant professor

Signature

ASSISTANT PROFESSOR
ISLAMABAD MODEL COLLEGE FOR BOYS
G-13/1 ISLAMABAD

Certificate for research tool validation

Certificate of validity

EFFECTS OF 5E'S INSTRUCTIONAL MODEL ON ACADEMIC ACHIEVEMENT IN 10th GRADE CHEMISTRY

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Name SIKANDAR HAYAT

Designation ASSISTANT PROFESSOR

Signature

Assistant Professor
Islamabad Model College for Boys
I-8/3, Islamabad

Certificate for research tool validation

Certificate of validity

EFFECTS OF 5E'S INSTRUCTIONAL MODEL ON ACADEMIC ACHIEVEMENT IN 10th GRADE CHEMISTRY

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Name - NAEEM AKHTAR

Designation- Assistant Professor

Signature-----

Naeem Akhtar
Assistant Professor
I.M.C.B, F-8/4 Islamabad

Appendix 9

F.1-107/2008 (Academics) FDE
Government of Pakistan
Federal Directorate of Education
****

Academics Wing

Islamabad the 13th March, 2023.

The Principal.
Islamabad Model School for Boys,
Noor Pur Shahan, Islamabad.

Subject: PERMISSION FOR CONDUCTING RESEARCH AND DATA COLLECTION.

I am directed to refer the captioned subject and to say that Mr. Irshad Hussain a student of International Islamic University doing research study on the topic **"Effects of 5E's Instructional Model on Academic Achievement in 10th Grade Chemistry"** requesting to visit your institution. In this regard you are requested to extend your cooperation regarding their research study.

2. The research scholar are required to forward a copy of thesis to Federal Directorate of Education after completion of the project.

3. This is issued with the approval of Director (Academics & Quality Assurance).

(DR. TABASSUM NAZ)
Deputy Director (Academics)
Phone #. 051-9262743

Copy to:
- AEO, Urban-II
- APS to Director (Academics & QA), Islamabad.
- Office File