

**EFFECTS OF PEDAGOGY-BASED-TECHNOLOGY ON
CHEMISTRY STUDENTS' PERFORMANCE IN HIGHER
EDUCATION INSTITUTIONS OF ETHIOPIA:
A CASE STUDY OF DEBRE BERHAN UNIVERSITY**

By

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UNIVERSITY OF SOUTH AFRICA

May 2012

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Submitted in accordance with the requirements for the degree of

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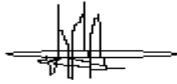
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May 2012

DECLARATION

I declare that EFFECTS OF PEDAGOGY-BASED-TECHNOLOGY ON CHEMISTRY STUDENTS' PERFORMANCE IN HIGHER EDUCATION INSTITUTIONS OF ETHIOPIA: A CASE STUDY OF DEBRE BERHAN UNIVERSITY is my own work and that all sources that I have used or quoted have been indicated and acknowledged by means of complete references.



Mr T.D. Hailegebreal

May 2012

Date

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<http://www.educypedia.be/educationchemistryjava.htm>and

<http://www.chem.iastateedu/group/grreebowe/sections/projectfolder/smdownload/ind4.html>

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SUMMARY

Many students have difficulty of learning abstract and complex topic in chemistry. This study investigated how students develop their understanding of abstract and complex topics of chemistry with the aid of visualizing tools: animation, simulation and video.

A particular focus of this investigation was to assess to what extent the uses of pedagogy based technology (PBT) is effective in learning chemistry. The combined effect of animation, simulation and video clips enable learning by doing and provide opportunity to explore the abstract and complex lessons of chemistry. The research was conducted with sequential embedded mixed research (quasi experimental and Explanatory) case study design. The experiment was carried out with second year chemistry students include 90(14 female and 76 male) students, 12 male chemistry lecturers and the college heads. The students were constituted 45 Control group and 45 Treatment groups. The groups were non-equivalent (convenient samples), suggesting that randomization was not possible as the students were in intact classes.

To apply animation, simulation and video in supporting student-centered learning activities of electrochemistry for second year students flash and micro media player were used. The treatment group was trained for two weeks how to operate and use animation, simulation and video software. Pre and Post tests were administrated to the target groups. The effectiveness of PBT was also evaluated by administrating separate Schedule containing open and closed ended questions.

The comments and ratings obtained from the learners' and lecturer insights provided the basis for the learning impact of the study. The result obtained from the

experiment and responses of the schedule shows that PBT improves the performance of students. Therefore, to make the abstract and complex concepts of chemistry easy and clear Electrochemistry learning should be supported by animation simulation and video. An extended study may help to understand the multi sensory benefit of Pedagogy-Based-Technology. Thus, a possible extension to this study should cover a variety of universities and should aim at evaluating its effectiveness in various context and subjects’.

Keywords: Pedagogy based technology, appropriate pedagogy, Animation, Simulation and video, abstract and complex lesson, student centered learning, electrochemistry

DEDICATION

DEDICATED TO MY Mother Trunesh Wondimtekahu

ACRONYMS

ANCOVA	Analysis of Covariance
CAI	Computer-Assisted Instruction
CAL	Computer Assisted Learning
CBL	Computer Based Learning
CBT	Computer Based Training
CMC	Computer Mediated Communication
IOM	International Organization for Migration
MOE	Ministry of Education
NCERT	National Council of Educational Research and Training
NETPTWG	National Educational Technology Plan Technical Working Group
PBT	Pedagogy Based Technology
TCA	Thematic Content Analysis
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNICEF	United Nations International Children's Emergency Fund.
WBT	Web Based Training
WWW	World-Wide Web

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CHAPTER ONE

INTRODUCTION

1.1. Background

Nowadays, chemical literacy is very important because many of the current problems are chemical in nature. If our Natural Science intellectual societies do not have chemical literacy, they will be unable to carry out recommended or the planned chemistry-informed issues at home, in the farm, recreation areas, the workplace and they will not be able to make their surroundings free from environmental pollution. It is also impossible to control the ozone layer depletion and there will no creativity to find alternatives for fossil fuel dependency (Bewicks, Edge, Forsythe &Parsons, 2009; Datta & Osaka, 2005).

During his stay as a lecture at Debre Berhan university researcher had observed many students have difficulty to understand concepts of Electrochemistry. However, Electrochemistry a branch of physical chemistry has numerous applications on the earth and everywhere in the universe such as electrical forces link atoms, molecules and all other kinds of matter together to form all kind of things.

Chemical literacy, therefore, is necessary for all individuals to be able to appreciate and support endeavors to improve quality of life and the society's standard of living. All science students, regardless of their study area or major, should acquire significant and tangible chemistry concepts (Datta & Osaka, 2005; Meyer, 2005). There are many useful reasons why we need to acquire chemical knowledge. As the 20th century progressed to an end, chemistry in general, and Electrochemistry in particular,

became more integrated within our daily lives. The production of electronic materials, different information media, dry cells, and different means of transportation on which modern society depends are a direct consequence of a better understanding of, and knowledge acquired through Electrochemistry. The substantial accomplishments in the field of medical science done by electronics materials, which have saved many lives and improved the health of countless persons, are the result of Electrochemistry. Improving human and animal health through the use of electronic materials is really dependent on Electrochemistry (Datta & Osaka, 2005; Meyer, 2005).

Ethiopia has energetic and powerful young generations to fulfill its motives towards making a great effort for economic and social prosperity. Ethiopia might exercise a fast recovery from long years of economic downturn and social turmoil (Kocsev, Hansen, Hollow & Pischetola, 2010). One of the main challenges of the country is delivering quality education (MOE, 2011; Negash, 2006).

The present educational policy of Ethiopia gives high priority towards improving teachers' qualifications, and quality of education in the public universities to produce effective professionals. To achieve this mission the government has built 13 new universities and has increased the total number of universities to twenty one (International Organization for Migration [IOM], 2008). Due to this expansion, the number of young people entering universities has increased but they choose study areas other than the Natural Sciences. This lack of interest young people show towards learning natural science is truly an issue of great concern that requires investigation. This shows a decrease in the number of students in the science field which is important to develop and fulfill the country's motive in science and technology. Show the way that

the Government of Ethiopia to launch the 70-30 strategic plan, in which 70% of the students at both secondary and tertiary levels involve in the areas of science and technology while 30% in social studies.

Ethiopian universities follow traditional and student-centred ways of teaching. Similarly in the Amahara Regional State there are five universities and the current learning and teaching process is also traditional and the student-centred approach but it has no digital technology application. Through this approach, in the last few decades the students could not understand the abstract and complex topics and were therefore not willing to join chemistry department at the tertiary level (McCormick & Li, 2006; Robinson, 2003; Sellers, Robert, Giovanetto, Fredrich & Hammargren, 2007).

With learning chemistry seen as a challenging task by many, its abstract and complex nature continues to be unattainable to most of the students. The difficulties may be due to the learning techniques as well as nature of the subject (McCormick & Li, 2006).

According to Tsapalis (2003), the abstract and complex nature of chemistry makes it to be seen as a difficult and disliked subject by lots of students. This shows that both traditional educational practices and newer constructivist delivery appear unable to solve these problems (Scardemalia & Bereiter, 2006; Taylor & Coll, 2001). As a result, the number of students enrolled in Natural Science is declining (Saint, 2004). For instance, at Debre Berhan University the nine natural and social science departments have a total of 1457 students in the academic year of 2008/2009. Of these only 50 were registered by their choice in the chemistry department.

These differences are seen most of the time when the new entry students heard about students who are engaged in learning some chemistry courses such as physical chemistry and achieve low grades. Owing to this, it is important for university science lecturers, in their roles as instructors, to think of a new level of duty, which help them to understand the different dimensions of their students' abilities. They also should know what beliefs they have themselves towards the pedagogical techniques designed to help their science students to attain intellectual maturity. Generally, to guide effectively as science lecturers they must plan techniques which enable their students to acquire the planned knowledge, skill and attitude. At the present time, the most preferable way of teaching is the student-centred techniques of teaching which need some amendment. This technique of teaching and learning stresses the importance of students' previous experiences considers individual needs and interest promoting active participation, inspires higher-order thinking, and encourages life-long learning (Hirumi, 2002).

Although lecture dominated teaching still exists in many educational institutions, integrating technology with various technique of learning becomes important in many discussions (Laurillard, 2002; Nsamenag & Tchobe, 2011). Its significance becomes increasingly indisputable. Currently, the perception of learning with technology is accepted as part of educational literature and the interest of many countries has progressively increased in integrating education with technology. In addition to this, many investigations also have shown that integrating technology with various technique and methods of learning improves learning and has a potential to change the future teaching /learning processes (Hui & Russell, 2009).

Integrating technology with the appropriate pedagogy is effective to make students interesting and success in acquiring various concepts of chemistry and motivates students' for further learning and inspire appreciation rather than a passive recipient (Aksela, 2005; Hsu, 2009).

This shows that the integration of computer assisted technology with constructive learning might help much to cultivate students' learning abilities. It helps the students to be absorbed, focused, attract their attention and increases their strength which are favourable conditions to construct their own meaning (Aksela, 2005; Hsu, 2009; Su, 2008; Windschitl & Andre, 1998).

Reasonable implementation of computer assisted technology to a great extent makes learning methods simple, flexible, and effective, owing to its potential to provide clear instructions.

The author of this thesis is inspired by the background he has as a chemistry teacher at high schools in many parts of Ethiopia and as a university lecturer of physical chemistry. He observed that many students have difficulties to understand the abstract and complex nature of chemistry including structures of atoms, molecules and compounds as well as the reaction process, how electron transfers shares and how particles form new compound after the reaction is completed. Consequently, there is a strong need for universities to find out effective and successful methods of learning that incorporate technology as an integral part. Despite the growing number of studies on diverse areas of this topic, there continues to exist a gap in our current knowledge and insight as to what extent most university lecturers utilize pedagogy-based technology to make their students have quality learning that increases the students' participation,

interest and performance, when employing such innovations. The author's main motivation for becoming involved in this research project was to investigate the potential that lies in digital learning materials like animation, simulation and video which can be extracted from various web sites, from different organizations formed for this purpose and from professionals who organize such type of software for different titles expected pedagogically and to check if these computer-assisted technologies can be a solution to visualize abstract and complex concepts of chemistry.

1.2. Purpose of the Study

The purpose of this study was to examine if any differences in academic performance exist between those taught with the conventional student-centred ways of learning and those taught by the integration of the student-centred technique with technology (animation, simulation and video). The latter was advanced in both pedagogy and suitable technology as a means by which course content can be delivered. As newer delivery modes enter the mix, the basic question that needs to be asked is whether the modes of delivery have any impact upon the student's overall performance in the course? Consequently, the focus of this study was to evaluate the effects of the integration of technology with pedagogy on students' work, interest and their performance in chemistry. This was to bring the understanding of how technology is integrated into the learning of chemistry and what kind of adaptation is needed to properly understand the context of technology in chemistry and the appropriate pedagogy for further implementation.

1.3. Statement of the Problem

Electrochemistry is habitually considered as a difficult course (Garnett & Treagust, 1992a, 1992b, Sanger & Greenbowe, 1999; Sirhan, 2007). However, understanding the concepts of electrochemistry is important to understand other related courses such as analytical chemistry, inorganic chemistry, environmental chemistry, industrial chemistry, material chemistry and so on. Failing to understand this concept of chemistry is failing to understand parts of these courses. It is obvious that many of the fundamental chemistry topics are based on the structure of particles that is to say that based on the dynamic nature of electron which can prove that Electrochemistry is an essential subject for students in view of the fact that, the chemistry curriculum at the university level commonly incorporates many abstract and complex concepts. Such concepts are central to further studies in chemistry and other sciences (Anderson, n.d.). These abstract and complex concepts are significant for further chemistry science concepts mastery (Mammino, 2009; Sirhan, 2007).

Having inadequate knowledge, skill and attitude in such courses including failing or dropping the course can cause a student to give up learning of chemistry courses. Therefore, it was important to investigate various approaches that help to learn chemistry, which enhance students' learning and inspire in them a renewed interest with the end result of having a higher accomplishment rate (Burge & Daubenmire, 2001).

As we have seen Electrochemistry is a part of physical chemistry that many undergraduate students are challenged with. Therefore, it is necessary to assess the students' challenges in learning Electrochemistry on an individual basis as well as on group basis. As lecturers we should understand the various reasons why students fail to

understand concepts. We must identify the specific difficulties students have and then we have to develop appropriate delivery to assist students in overcoming these difficulties (Herron 1996; Sirhan, 2007).

One of the characteristics of learning chemistry is the thinking about the interchange between the macroscopic and microscopic (abstract) levels of thought. Owing to this there are difficulties in visualizing atoms, ions and compounds in three dimensions which causes a problem in understanding the abstract and complex concepts of chemistry learning such as electrodes reactions, movement of ions and electrons that make university physical chemistry learning most difficult and challenging.

Many of the Debre Berhan university students are not able to understand the chemical phenomena in Electrochemistry. Chemistry by its nature has some difficult contents that require high-level mental and manipulative skills of calculations in different chemistry topics, therefore, to avoid further trouble, the abstract and complex nature of chemistry needs specific consideration. Since, considering chemistry as a difficult discipline repel students from continuing studying chemistry, and it is this feature of chemistry, particularly physical chemistry learning, that represents a significant challenge to chemistry students (Duit, 2007; Sirhan, 2007).

However, employing carefully prepared suitable technology integrated with appropriate pedagogy can help the chemistry students' to visualize atoms, ions and compounds in three dimensions. This enables them to acquire factual knowledge and skills, and there would be proper learning too (Acar & Tarhan, 2007).

Traditional educational practice with its emphasis on knowledge transmission and the newer constructivist methods appear to be limited in their specificity to visualize abstract and complex concepts (Bucat, 2005; Scardemalia & Bereiter, 2006).

These indicators of weakness provide clue to employ computer-assisted technologies that have capabilities to give powerful means to present chemical phenomena in a clear and understandable way. Computer simulation and animation, particularly the dynamic computer animations have contributions which enable students to understand deeply the concepts of electrochemical phenomena that are not directly perceivable by other means (Mork, 2005).

As a result, there is a need to find rational ways to incorporate the pedagogy designed technology into chemistry education. So, examining the effects of pedagogy-based-technology that is to say, integrating student-centred approach with animation, simulation and video on abstract and complex Electrochemistry lessons of second year chemistry students and examining their performance can inform us about the consequence in learning abstract and complex concepts of chemistry.

1.4. Objectives

The main objective of this study was to identify if there was any difference in students' performance when the complex and abstract concepts of chemistry are taught using the student-centred approach integrated with animation, simulation and video (Pedagogy-Based-Technology (*PBT*)) and when taught using the student-centred methods in electro chemistry learning at the Debre Berhan University in Ethiopia.

The specific objectives are:

1. To investigate the effects of PBT on the performance of second year chemistry

students towards in electrochemistry.

2. To assess the perception of chemistry lecturers and students about the use of PBT in chemistry learning at Debre Berhan University.
3. To suggest possible ways that can reduce the abstractness and complexity in chemistry learning.

1.5. Basic Research Questions

In Ethiopian, university students taught chemistry habitually with lecture and experimental type of learning; however, most of the students have difficulty in leaning abstract and complex concepts of chemistry (Sirhan, 2007). Then, what type of learning environment do instructors need to teach the abstract and complex concept of electrochemistry?

In line with this, the question addressed in this research is:

To what extent would the use of technologies – animation, video and simulation in learning electrochemistry reduce students' misunderstanding and improve their learning performance and interest in electrochemistry?

To address the above the following sub-question were formulated

1. What are the effects of PBT on students' performance in electrochemistry?
2. What are the effects of PBT on students' attitudes to (Electro) Chemistry?
3. What are the perceptions of students and lecturers of the use of PBT in teaching difficult concepts in Chemistry?

1.6. Hypotheses for the Study

To further guide the study, the following two hypotheses were formulated and test at 5% level of significance (alpha level of 0.05000).

Hypothesis1. There is no significant difference in students' academic performance in electrochemistry when taught using PBT and when taught using conventional method ($p < 0.05000$). $H_o = \mu_1 - \mu_2 = 0$

$H_0: \mu_1 = \mu_2$. Where μ_1 = population mean of the control group (the students who have learned by student-centred technique of teaching and μ_2 = population mean of the experimental or treatment group (who have learned by the student-centred integrated with animation, simulation and video = PBT).

However, in the case of paired data, it is a common practice to make use of the fact that the difference between the two population means (i.e., $\mu_1 - \mu_2 = \mu_d$)

Where μ_d = the population mean of the difference in scores.

Hypothesis 2 There is no significant difference between the mean scores of experimental group and control group in their performance in electrochemistry, ($P < 0.05000$).

1.7. The significance of the study

This study investigates deeply into technology integration at the university level rather than simply revealing characteristics of a general survey. Therefore, the study is significant for the following points:

1. It will create awareness about the role PBT plays in the chemistry teaching and learning in the university environment.
2. It will point out the effects of PBT in improving the performance of chemistry students in difficult and complex Chemistry concepts at the tertiary level of education.

3. It will bring changes in our understanding of how students learn and how this is applied to chemistry learning at the University.
4. It will help chemistry novice lecturers and students to visualize the usual abstract and complex topics in chemistry thereby increasing students' interest, perception and achievement in the subject and related disciplines.

1.8. Delimitation of the Study

This study was conducted in Ethiopia at Debre Berhan University. More specifically the study focuses on second year chemistry students. It examined deeply the effects of integrating animation, simulation and video with the student-centred techniques of learning as a case study, the perception of the students and lecturers, how and where it is implemented in learning chemistry at the university level.

1.9. Definition of Operational Terms and Constructs

Complex concept – intricate, multifarious concepts consisting of many different and connected parts not easy to analyze or understand

Computer-assisted learning - process of providing, operational and learning software engaging students in activities of computer equipped classroom in which the students operate, retrieve and examine the various chemical phenomena

Learning Environment - those instructional settings which include physical, pedagogical and social aspects in which learning occurs and that helps change students' performance, skill and attitude including, for example, a digital computer equipped learning environment.

Pedagogy-based-technology - an integration of appropriate student centered technique of learning (pedagogy) and subject knowledge with technologies such as: computer animation, simulation and video

Performance - is the achievement or the test results of students.

Student-centred learning - is a method of learning in which students are active participants and significant role players. This method does not only provide information (knowledge) rather it compels students to collect information, record it systematically, discuss it, compare it and draw conclusions. These techniques give chances for students to learn actively by their own. Teachers with these techniques play a guiding role in organizing the activities through which students learn, check the work of students, their progress and ensuring whether they are learning or not. Therefore, the teacher has always to be there to assist and to provide guidance, ask questions and give answers, clarify instructions, etc.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1. Introduction

This chapter is organized into nine parts. The first is an introduction, and the second deals with the theoretical framework on which the study is based, the third part of this chapter examines the difficulty in chemistry learning, the source of difficulty, the reason how difficulties arises and the level of difficulties The fourth part of this chapter, elucidate the rise of educational technology, where computer first appeared its improvement and its rapid development. The fifth section is about research concerning the computer assisted learning and how computer and different learning software are integrated to form a suitable learning environment. The sixth section reveals the rich learning environments, how this is related with quality education and quality learning environment includes:

An environment which is gender-sensitive has enough services and resources, healthy, secure and protective circumstances, trained teachers, student-centered learning processes, well-managed classroom, and skilful assessment to facilitate learning that can reduce inequality. The outcomes include knowledge, skills and attitudes, which are associated to the national goals of education and positive participation of society (UNICEF, 2000).

It also discusses the constructivist approach and the importance of technological application to visualize abstract and complex lessons of chemistry. The seventh section

explains PBT and the importance of integrating appropriate pedagogy with suitable technology for chemistry learning. The eighth reviews the challenges in integrating technology with appropriate pedagogy and the final part is a summary.

2.2. Theoretical framework

Learning environment is essential for quality of learning which comprises safety, the physical environment, the social system and relations between organizational units such as lecturers, students and other supportive staffs; lecturer and student, and the tradition among peers. It is also shown that learning environment has important influences on students' academic achievement, their health, personal and social progress (Cohen, 2006; Organization for Economic Co-operation and Development [OECD], 2009).

The learning environment is more than the furnishing of student's immediate classroom and library which is a small fraction of it. Students can get a lot, informally from their surroundings such as public meeting, conferences, supportive staffs, spaces; drama studios; laboratory; virtual learning environments; lecture theatres; seminar rooms; café, innovation rooms and relaxation lecture theatres (Hartley, Woods & Pill ; 2005).

Moreover, to attain quality learning both individual student and the social interaction are important; corresponding to this the cognitive constructivism states that learning is the acquisition of information and occurs in the mind within the individual when new incoming information is connected to the pre-existing ideas and related old knowledge (Piaget,1952,1970; Bruner,1974; Pritchard, 2009). Alternatively, the social constructivism; stressing the social context, the interaction of students, culture and cooperative side of learning and stated for learning to occur, the students needs

interaction with many students experience to connect it correctly with their pre-existing knowledge(Palmer, 2005; Woo& Reeves,2007). Therefore, using a variety of learning strategy is important for students learning. The use of mixed techniques of teaching enables to deliver effective, high quality and standards-based learning. These engage all students in active learning and help to monitor their progress toward mastery of the planned content of chemistry. With classroom organization, employing suitable techniques with adequate experience, appropriate instructional time, and effective lecturer may create and maintain an engaging and productive classroom learning environment that promotes students' academic growth. As members of a professional learning community, effective lecturers are able to build relationships, improve their students' learning, and empower their students' with the necessary skills to serve themselves and their countries (Bullard & Felder, 2007).

For a number of years learning was reliant on rote memorizing and learners were passive recipients which makes understanding of many subjects difficult. To change this classroom practice there were a number of investigations and a number of innovative technology mediated models and learning processes that have been applied in higher institutions and in schools (Arasasingham, Taagepera, & Potter, 2005; Duhaney,2000). These findings in some cases were negative but in most cases positive to engage students into their activities and to facilitate learning. Many new facilities start out with sound pedagogical objectives and many learning situations often reflect the essential feature of technology in learning. Technology can be used in a variety of ways and for different purposes in the classroom (Arasasingham, Taagepera, & Potter, 2005). There have been many attempts to describe the use of technology various subjects in different

educational settings in a more systemic way to maintain the appropriate balance between pedagogy and technology as a basis for the design and evaluation of teaching (Rogers, 2002). Due to this, there was growing interest in higher education institutions, to establish new types of learning environments, supporting student-centred or constructivist pedagogy, nationally and internationally (Ghaoui, 2007). But none of them expressed how and at what time it is required. Then, what is required is a genuine understanding of how technologies can be used effectively (Gao, Doris, Wong & Wu, 2009).

Today, technology has become part of many things which are developed to solve the problems that are associated with human needs. Quality education is one of the key human needs for growth and improving life. Employing and adopting technologies in the learning process that address many educational problems would have greater values. Technology provides the opportunities to change the nature of the learning environment. Technology helps students in learning, in the context of those global issues. The combined effect of software and sophisticated media may support learning, but at the same time it may divert the learning process from the actual track by providing unnecessary information (Lemke & Coughlin, 2009).

Furthermore, technology should not be adopted by educators where there are no perceived needs. Therefore, when discussing applications of computer technology to education, the question must be what educational problem(s) needs to be addressed (Lemke & Coughlin, 2009)? This should also be known by all parties of the learning system such as the top management, the expert developing the policy and the strategic

plans, lecturer planning the programme and university administrator purchasing hardware and software.

On the other hand, lecturers and students may choose learning focus on technology, its capabilities, and thus what can be technically accomplished in terms of creating lessons and modules. Inappropriate use of technology may lead in the wrong direction and depart from the intended learning outcomes. As well, placing the primary emphasis on technology increases the risk of that people or organizations end up with technically advanced but intellectually poor experiences (van Merriënboer, Bastiaens, & Hoogveld, 2004).

As Harris, Mishra and Koehler (2007) argued most of the current technology executions in learning are incorrect and it has failed to notice complete relationship connecting technology and pedagogy. They emphasized that the perception of how to implement new educational technologies into the learning process must be improved more than the use of tools and has deep implications for the nature of content-area learning. The pedagogical approaches the lecturers select are important and have to be appropriate otherwise it may follow by unnoticed aspect of technology integration approaches.

Then, how can lectures integrate technology into students' learning? According to Koehler & Mishra (2009) there is no "one best way" to integrate technology into curriculum. Rather, integration efforts rely on the needs and the necessities of the pupil for a *particular* subject matter in specific classroom contexts. There was no care how to integrate with suitable techniques, treating learning as an interaction between what teachers know and how they apply based on what they know in the unique

circumstances or contexts within their classrooms (NCERT, 2006). Organizing appropriate approaches to have successful technology integration requires educators to develop new ways of comprehending (NCERT, 2006).

Moreover, the learning process is a conspicuous effect of reinforcement, interaction with the surrounding environment and practical problems of education which makes the rate of acquisition of skill and knowledge important. But complex behavior is acquired at different speeds because of interactions among responses and stimuli. Change of behavior and its value depends upon whether reinforcements continue in effect. When effective reinforcements are abundant, the individual is likely to be energetic, enthusiastic and interested. When reinforcements are insufficient, students' are likely to be uninspired and discouraged. The positive inspiration leads to interaction and creation of their own meaning or acquisition the true concepts. The reinforcement of verbal behavior through mediation implies certain conditions which have important effects upon the dynamic properties of the behavior (Bower, 1972; Gregory, 1987; Skinner, 1957; Skinner, 2005).

Corresponding to this, in this study the ultimate objective of using the combined effect of animation, simulation and video expected to causes the behavioral change by making the abstract nature and complex concepts of chemistry visible based on the external real world and function, on the one hand, and how this invisible chemical phenomenon happens, on the other.

The obvious route to this goal is collecting professionally designed abstract and complex topics' software based on the known physical external environment using a

continually fast changing technology with the intention of acquiring clear concepts from a certain specific topic to change the behavior (Ghaoui, 2007).

2. 3. Difficulties in Chemistry Learning

It is through formal and/or informal education that an individual can be equipped with the knowledge, skills and attitude needed to be a successful citizen, which helps him or her to adapt to the ever changing political, social and economic environment (UNESCO, 2003).

Many chemistry concepts and phenomena are abstract and complex, which can be understood and communicated only through the use of chemical representations (Hilton, Nichols & Gitsaki, 2010). Along with this, understanding of chemical processes and phenomena such as dissolving substances, transfer of electrons, conduction of ion, inter molecular and intra molecular bonding as well as the dynamic nature of phenomena is fundamental to learning the chemistry at the university. But the university students have difficulties to understand this chemist's conceptual representation of the microscopic particles. On the other hand, when misconceptions or alternative misconception occurred it will hinder further chemistry learning (Gupta-Bhowon, Jhaumeer-Laulloo, Kam Wah, & Ramasami, 2009; Simsek, 2009).

It is important to identify factors affecting students understanding of the abstract and complex concepts of chemistry in their effort to construct their own meaning. This is the key to quality chemistry learning at the university level. This suggests that lecturers should have to prepare an appropriate, clear and an interesting learning environment engaging their students in the participatory learning process that increases their positive attitude towards chemistry learning (Coll & Taylor, 2001).

Furthermore, the arrangement, composition and formation of compounds is the other most important concept in chemistry: the shape and structure of atoms, molecules and ions, including their bonding and the location of electrons, are determining factors in understanding the concepts of chemical reactions and the uses of chemical substances. Thus, conceptual understanding in chemistry includes the ability to represent and translate chemical phenomena using macroscopic (observable) to atomic, molecular and ionic (particulate), and symbolic forms of representation. Students at the university level should think at the particles (molecular, atoms, ions) level and explain changes at macroscopic level in terms of interactions between individual atoms, molecules and ions (Gupta-Bhowon et-al., 2009). However, this is the most difficult and challenging in chemistry learning at the university level. The students have difficulties to illustrate the three-dimensional structure and dynamic interactions of atoms, molecules and ions. This shows that they have difficulties to visualize atoms, molecules and ions in three dimensions and are not able to understand various chemical phenomena (Tsaparlis, 2003; Mahaffy, 2005). Based on the findings of Tsaparlis (2003) and on the above mentioned studies, students' difficulties and misconceptions about "atomic structure and bonding" may be attributed to one or more of the following factors:

- ⇒ Inability to visualize atoms and molecules in three dimensions.
- ⇒ Failure to employ formal operations.
- ⇒ Lack of association or reorganization for learning about these topics since concepts related to atomic structure and bonding are usually built on entirely new grounds.
- ⇒ The way the topic has traditionally been taught in classroom situation (McCormick & Li, 2006; Jennings, Epp & Weaver, 2007; Sellers, et-al., 2007; Simsek, 2009).

Consequently, as expressed by many research reports, the difficulties in chemistry arose from the abstract, complex and dynamic nature of the concepts covered, bulky course content, teacher-centered teaching, erroneously constructed students knowledge due to lack of clear vision and lack of motivation. Learning can be long-lasting when students learn electrochemistry contents by relating with their everyday real activities but this was not happened by teacher centered teaching that leads them to wrong understanding of concepts(Robinson, 2003; Tsaparlis, 2003; McCormick & Li, 2006; Jennings, et al., 2007; Sellers, et-al., 2007; Simsek, 2009).

The student's curiosity and interest are only satisfied when the content to be learned is clear and understandable (Duarte, 2000). Therefore, making the abstract and complex concepts clear and obvious is indisputable and also requires the lecturer's personal effort to build an interesting learning process, so that the student relates the content to be learned to personally meaningful contexts and/or to existing prior knowledge. The making of learning material appropriate helps students to acquire the concept clearly and deeply, to make the students' learning process enjoyable and continuous, to have better retention of the content to be learned, to achieve better quality of learning and to have more structured mental representations. The deeper comprehension and the higher level of creativity of the student, allows them to comprehend thoroughly the different aspects of the learning task on the basis of the student's previous knowledge and often enables to solve new problems adequately (Duarte, 2000).

Moreover, several reports show sources of difficulty for learning chemistry are the incorrect conception of kinetic theory and the incapability of students to concretize

the abstract and complex nature of chemistry topics arising from the interplay between macroscopic and microscopic worlds (Abraham, Grzybowski, Renner, & Marek, 1992; Taylor & Coll, 1997), the perception about enhancing students' conceptual understanding (Barker & Millar, 2000; Harrison & Treagust, 2000), the conception of chemical bonds and energy (Barker & Millar, 2000; Boo, 1998), the concepts of intermolecular forces (Barker & Millar, 2000; Tan & Treagust, 1999), the feeling about solution chemistry (Çalık, Ayas & Ebenezer, 2005, 2006; Pınarbaş, & Canpolat, 2003), concepts of mental models (Coll & Taylor, 2002; Coll & Treagust, 2001a, 2003; Taber, 2002), perception of metallic bonding (Coll & Treagust, 2001a), thoughts about ionic bonding (Coll & Treagust, 2001a; Coll & Treagust, 2003), perception about bonding (Coll & Treagust, 2001b; Nicoll, 2001; Tan & Treagust, 1999), awareness about chemical bonding (Coll & Treagust, 2003; Özmen & Ayas, 2003; Özmen, 2004; Taber & Coll, 2003; Ünal, Çalık, Ayas & Coll, 2006), the opinion on Electrochemistry (Garnett & Treagust, 1992a, 1992b, Sanger & Greenbowe, 1999), the mole concept (Gilbert & Watts, 1983), the concepts about atomic structure (Harrison & Treagust, 1996; Zoller, 1990), thought about thermodynamics (Özmen & Ayas, 2003; Sirhan, 2007), idea about balancing redox reaction and stereochemistry (Zoller, 1990) and the outlook about chemical change and reactivity (Zoller, 1990).

Rooted on these, the processes of Electrochemistry learning have many confusing concepts which explain its complex and abstract nature. According to (Grayson et al., 2001) there are four levels of difficulties which the framework comprises that indicate how much are known by the researchers. Some of the most important concepts of Electrochemistry lessons are presented below.

Level. 1

Under difficulty level 1 are those in which the unexpected difficulties emerge during understanding of the concepts when the students learn.

- ❖ In a cell the anions and cations attract each other and this affects the movement of ions to the electrodes.
- ❖ In an electrochemical cell the anions and cations move until their concentrations in both half-cells is equal.
- ❖ In galvanic cells, the cathode is the electrode from which electrons are released (oxidation). It is the minus pole of the cell.
- ❖ Electrolytic cells can force non-spontaneous reactions that do not involve electron transfer to occur.
- ❖ In an electrolytic cell, when two or more oxidation or reduction half-reactions are possible, there is no way of determining which reaction will occur.
- ❖ In electrolytic cells with identical electrodes connected to the battery, the same reactions will occur at both electrodes.
- ❖ Half-cell potentials are not intensive properties.
- ❖ An ionic compound conducts electricity in aqueous solution but not when solid because free electrons are produced when the ionic compound is dissolved in water.
- ❖ Only negatively charged ions constitute a flow of current in the electrolyte and the salt bridge of an electrochemical cell.
- ❖ Protons and electrons flow in opposite directions in electrolytes.
- ❖ Protons flow in electrolytes regardless of whether the solution is acidic, basic or neutral (Garnett, Garnett, & Hackling, 1995; Garnett & Treagust, 1992a, 1992b; Ogude & Bradley, 1996; Othman, Treagust & Chandrasegaran, 2008; Ozkaya, Uce and Sahin, 2003; Sanger & Greenbowe, 1997a, 1999; Schmidt, Marohn & Harrison, 2007).

Level. 2

Concepts which are grouped under difficulty level 2 sources are suspected by researcher reports on the basis of teaching experience.

- No reaction occurs at the electrodes if inert electrodes are used in a galvanic or an electrolytic cell because inert electrodes are not altered chemically in cell reactions.
- Electrolysis is an exothermic process.
- The two electrodes in electrolytic cells are charged, positive and negative.
- There is no relationship between the calculated cell potential of an electrolytic cell and the magnitude of the applied voltage.
- Standard reduction potential tables list metals in order of decreasing reactivity from the top down.
- Electrode potential is equal to the electrochemical potential difference between the metal and electrolyte in the half-cell.
- The value of zero for the standard potential of the $\text{H}_2(1\text{atm})/\text{H}^+(1\text{M})$ standard half-cell is somehow based on the chemistry of H^+ and H_2 because hydrogen is in the middle of the activity series for metals.
- Half-cell potentials can be used to predict the spontaneity of the half-cell reactions because some half-cell potentials are positive while others are negative in value.
- When an electrode is immersed into an electrolyte, an electrical double layer does not form at the interface between the electrolyte and the electrode immersed in it.
- In standard reduction potential tables, the species with the highest reduction potential (the most positive E° value) is the anode in an electrochemical cell (Garnett, & Hackling, 1995; Garnett & Treagust, 1992b; Ogude & Bradley, 1996; Ozkaya, 2002; Ozkaya, et al., 2003; Sanger & Greenbowe, 1997a, 1999; Willson & Williams, 1996).

Level. 3

Concepts which are grouped under difficulty level 3 source are partially established difficulties; i.e. identified in limited contexts with descriptions still open to change are:-

- ☞ During electrolysis, an electric current breaks the electrolyte into positive and negative ions / produces ions.

- ☞ The predicted cell potential for an electrolytic cell may be positive.
- ☞ Water does not react during the electrolysis of aqueous solutions.
- ☞ Processes in electrolytic cells are the reverse of those in electrochemical cells: in electrolytic cells, oxidation occurs at the cathode and reduction at the anode; in predicting the electrolytic reaction, equations from standard potential tables are reversed before combining them.
- ☞ In an electrolytic cell, no reactions will occur at the surface of inert electrodes/ no reactions will occur if inert electrodes are used.
- ☞ In electrolytic cells, the polarity of the terminals of the applied voltage (the direction of the applied voltage) has no effect on the reaction or on the site of the anode and cathode (Garnett & Hackling, 1995; Garnett & Treagust, 1992b; Ogude & Bradley 1994, 1996; Ozkaya, et al., 2003; Sanger & Greenbowe, 1997a, 1999; Schmidt, et al., 2007).

Level 4

Based on the idea that electrons travel through electrolytes and the salt bridge, an alternative framework exists (Garnett and Treagust 1992b) concerning the nature of electric current in electrolyte solutions. These alternative frameworks grouped under the difficulties in level 4 are identified in a number of contexts and for which there is a stable descriptions are:

- ✓ Electrons flow in electrolytes
- ✓ The flow of electrons constitutes electric current in electrolytes.
- ✓ Electrons enter the electrolyte at the anode, move through the electrolyte solutions and the salt bridge, and emerge at the cathode (to complete the circuit).
- ✓ When an electrolyte conducts a current, electrons move onto an ion at the cathode and are carried by that ion to the anode.
- ✓ Electrons move through solution by being attracted from one ion to another.
- ✓ Electrons move through electrolytes by being attracted to positive ions in the solution. Electrons can flow through aqueous solutions without assistance from the ions.
- ✓ The salt bridge supplies electrons to complete the circuit.

- ✓ The salt bridge assists the flow of current (electrons) because positive ions in the bridge attract the electrons from one half-cell to the other half-cell.
- ✓ Cations in the salt bridge and the electrolyte accept electrons and transfer them from the cathode to the anode.
- ✓ Anions in the salt bridge and the electrolyte transfer electrons from the cathode to the anode.
- ✓ The movement of ions in an electrolyte does not constitute an electric current (Garnett & Hackling, 1995; Garnett & Treagust, 1992b; Huddle, White & Rogers, 2000; Ogude & Bradley, 1996; Ozkaya, et al., 2003; Sanger & Greenbowe, 1997a, 1999; Schmidt, et al., 2007).

Naturally chemistry learning is extremely conceptual. Using the same technique of learning for a long time or repeatedly may help the student to recall some main points only on the exam but it does not help to acquire clear, long-lasting and applicable concepts. True understandings require appropriate, varied technique of learning and suitable learning environments. According to many research reports, if students learn only for the purpose of recalling on the exam paper there appear misconception and incorrectly understand the properties and characteristics of particles in a certain areas of basic chemistry. Even such type of situation appears at the degree level in higher institutions (Bodner, 1991; Johnstone, 1991): What is taught is not always what is learned. To what extent would the use of technologies – animation, video and simulation in teaching electrochemistry reduce students' misconceptions and improve their learning achievement and interest in electrochemistry? This is the major question which this study intends to answer.

2.4. The Rise of Educational Technology

Educational technology can be defined as a collection of tools which can be used to improve students' learning (Abdoolatiff, 2009; Sewall, 2011). Educational technology therefore comprises a broad definition of technology. Technology includes a large number of material objects that can be used or serve various purposes such as systems, methods and techniques of organization or it can be a computer, printing machine, and grinding machine, printed materials, or modern tools like over head projectors, laptop computer, calculators, and mobile telephone. Or it can be the newer tools such as smart phone, games that are both online and offline or any digital materials.

Computer-Assisted Learning began to draw serious attention in learning during the early 1900s (Gulińska, 2009; Abdoolatiff, 2009; Sewall, 2011). However, educational technology appeared as a learning material with the emergence of very early tools such as paintings on cave walls. Nevertheless, the dynamic educational technology started with educational films in 1900s or Sidney Pressey's mechanical teaching machines in the 1920s (Sewall, 2011).

The use of large scale technology was first started during the training of the United States soldiers for the Second World War through films and other mediated materials. However, currently, the presentation based technologies are widely used by assuming that the people can learn more with the help of audio and visual treatments. These technologies are employed and exist in many forms such as the different forms of audio and video, power point presentation with voice explanation. The hypertext containing an interesting application appeared in 1994 for instance V. Bush memex (Ann, 1994; Asaolu, 2006; Baier & Strong, 1994; Jim & Sayers, 1995)

In addition to these, the 1950s appeared with two interesting and popular designs. Among them Skinner's work "programmed instruction" which breaks instructional content into small units and rewarding correct responses that deal with change of behavior and focusing on the formulation of behavioral objectives. While the second advocating a mastery approach to learning based on his taxonomy of intellectual behaviors were the leading. Based on this, Bloom declared instructional techniques that varied both in time and the teaching processes according to student requirements. On the other hand, the late 1960s was the time in which computers were used intentionally for education purpose with computer based instruction on public meeting and so on.

Besides this, the "Computer-Based Training" (CBT), computer-aided instruction or Computer-Assisted Instruction (CAI) based designs appeared in 1970s to the 1990s. These designs are similar in most of their character and content with today's "e-contents" that often form the core of "e-learning" set-ups, which is sometimes called online or 'Web-Based Training' (WBT) or 'e-instruction'. The course designers were cautious. They were dividing learning contents into smaller portions of text augmented with graphics and multimedia presentation (Ann, 1994; Asaolu, 2006; Baier & Strong, 1994; Jim & Sayers, 1995; Sewall, 2011).

The use of computers first started in the specialized science schools such as natural science schools and vocational schools in the United States of America in the late 1970s and the early 1980s. With the extension to this, the 1980s and 1990s produced a variety of schools that put under Computer-Based Learning (CBL) umbrella. During this time the schools preferably used micro-worlds technologies specifically computer environments where students could investigate and build simulations, play

with parameters of dynamic systems and hypertext (Ann, 1994; Asaolu, 2006; Baier & Strong, 1994; Jim & Sayers, 1995; Kennepohl, 2001).

However, the digitized communication and networking in education particularly through the World-Wide Web (WWW), e-mail and forums was started in the mid 80s and became popular by the mid-90s. There were two major forms of online learning. The first type, based on either Computer Based Training (CBT) or Computer-Based Learning (CBL) and focusing on the interaction between the student and repeated computer exercise plus tutorials on one hand and the second was micro-worlds and simulations.

Today, both can be delivered through WWW. However, nowadays, the prevailing paradigm in the regular school system is Computer-Assisted Learning or Computer-Mediated Communication (CMC), where the interaction is primarily based on students and instructors that are mediated by the computer. The CMC involves teacher/tutor facilitation and requires organized and flexible learning environments and activities. However, CBT/CBL system of computer mediated learning is individualized base learning. In addition, to have sustainable system of learning, the communities and the associated knowledge management should connect with the information communication technology which provides education supported with appropriate curriculum and suitable tools (Abdoolatiff, 2009; Gulińska, 2009; Setzer, 1997; Sewall, 2011).

Even though, the quality learning processes still take place based on a paper, videos and occasional CBT/CBL materials, learning with technologies can play a major role in regular and distance learning. There is also an increased use of e-tutoring through forums, video-conferencing, instant messaging, etc. In the distance activities, the

blended or hybrid designs which occur usually at the beginning and at the end of a module that mix the presentation of courses with the use of various pedagogical styles (e.g., drill & practice, exercises, projects, etc.) is also frequently used to address courses to smaller groups. All these technologies have their own contribution to enhance the classroom learning and increase the quality of learning.

Multiple mobile and ubiquitous technologies that appeared in the year 2000 have given a new need to the situated learning theories assisted learning-in-context scenarios. Some literature uses the concept of integrated learning to describe blended learning scenarios that integrate both school and authentic settings (e.g., workplace).

Computer-Assisted Learning has a relatively short history in the educational system, but it has an amazing progress to enhance and improve the present learning processes. Starting from its first introduction into schools up to now, it has a large number of technological applications to transform and change learning and has important features that may have a major impact on learning. Computer-Assisted Learning is participatory and can be used to accomplish extremely varied purposes, for instance providing simulations for dangerous or expensive laboratory activities as well as make clear the complex (Access center, 2007). But for what type of concept the impact occurred was not clear and was not the concern of the designer and instructors.

The technological revolution has contributed a large number of developments to change many areas of education, but it was in the mass form of one-way information transfer. For example, public broadcasting prevents individual learning and group interaction because it does not reflect individual needs and has no time for interaction, correcting the misunderstandings to assimilate the correct one. The sequential

presentations, such as tapes and videos, do not allow for working with the piece of information actually needed. This means they can only play a role of supplementary specialized activities (Kozma & Russel, 2005; Setzer, 1997; Soika, Reiska & Mikser, 2010).

At the present time, computers can do a variety of things, starting from a simple writing machine up to clarifying the complex and abstract learning phenomena. However, in accordance of the Ethiopian higher institutions context, not all teachers are employing computing. They were not user-friendly and there were little to no options for application to the curriculum. But some research reports confirmed that the computer is the future promising learning tool (Soika, et al., 2010). In the very near future computers will become the private property of individuals and this will gradually return learning to the individual and will have the power to determine patterns of education. Education will become more of a private and collective act; there will be new opportunities for imagination and originality. Computers may be used individually or in groups in a cooperative learning environment where students can discuss the concept as it is learned. Teachers may also review learning phenomena to keep the student in track and guide them properly (Abdoolatiff, 2009; Gulińska, 2009; Kozma & Russel, 2005; Sewall, 2011; Soika, et al., 2010).

Since then, the Web has been growing at an unbelievable rate and has become a system that has not only completely changed the importance of hypertext and hypermedia but also has had a strong influence on many fields of learning and education with information technology as a whole. Thus, it's possible to say the internet and "virtual world" can support active participatory or student-centred learning by providing

students and lecturers with practical, real-life experiences as well as resources, which can be used for various topics (Harrison, 2009).

For the purpose of this research educational technology refers to a Computer-Assisted Learning such as animation, simulation and video which helps to visualize the abstract and complex lessons and to support student centred learning.

2.5. Computer-Assisted Learning and Learning Strategy

Being able to plan suitable learning approaches and creating suitable environments helps to establish a very powerful tool which can motivate, create a true image and inform students, particularly those who respond to a strong visual stimulus. Combining text with different types of image in simple animated order can make topics clearer and more inspiring. Mainly preparing learning environments with true visual presentations can make learning easier and assists to control the flow and pace of lessons. It can help the students to engage in the process and to be acquainted with ideas what is coming first and ‘what’s coming next’, questioning, which may lead them in writing possible responses before expressing their answer. Developing this type of approach in the classroom means that students are more likely to make effective use of this type of learning when they access it personally and in group (Lewis, 2003).

Technology integrated with pedagogy is proposed to improve education. Some of the claimed benefits are listed below:

- It enables to motivate students. Computer assisted learning can provide dynamic pictorial illustration and give an immediate criticism to students that inspires them to learn. Moreover, a computer is patient and non-judgmental, which offer

students the opportunity to think and to give their own conclusion. Usually students learn more in less time, like their classes more and develop more positive attitudes toward learning.

- Suitable technology integrated with appropriate pedagogy enables us to control the learning process: when the computer-assisted learning is integrated with suitable techniques of learning used at higher institution where both the students and the lecturer have relatively better exposure for computer, it can help the students to think thoroughly, make learning clear and help them acquire the true concepts. It is also the basis for successful academic performance.
- It can access many geographical areas. Soft copies and software learning materials can access long distance learning environments easily and cheaply, and are accessible to a wider audience.
- It can make the subject easier to learn. Many different types of educational software and programs have been designed and developed to help students at all levels of study, including pre-school, junior school, high school and higher institutions, software, computer simulators, animation and graphics software enable to see things from various perspectives, it makes concepts clear and thus create interesting leaning environments.
- It presents structure that is more truthful to measurement and improvement of outcomes. A computer with suitable soft ware or program presents understandable image. When the lesson presented clearly it become easier to monitor and maintain students' attention and to increase interest while they are observing, measuring and doing things for themselves.

- Differentiated learning. Educational technology provides the means to focus on active student participation and to present differentiated suitable learning strategies. Technology integrated with pedagogy can present the subject matter consistent with the needs of students: it can present individual-based, group-based learning; specifically the individual learning helps to broaden individualized instruction and promotes the development of personalized learning strategies. Thus, students are encouraged to use different types of instructional media and to incorporate the knowledge they gained in creative ways (Biggs & Tang, 2007).

Based on these, some research reports claims that the preparation and utilization of the blend approach is the most successful approach to integrate technology into pedagogy. According to them, blended learning a) enable the attainment of learning objectives more effectively than traditional approaches (b) increases interaction and student to student contact, and student to instructor, (c) presents more diversity for lecturers, and (d) participating more students learning than traditional approach (Georgina & Olson, 2008).

It is obvious blended learning is better than traditional learning but still it has its own inadequacy, since it does not enable students to create their own meaning rather it is dependent on the lecturers (Felder & Brent, 2009). So, there is a gap which can be filled with the assumption, that a student-centred approach enables the student to create their own meaning. For the reason that, in student-centred learning, the teacher is a facilitator and guider, who organizes and prepares appropriate learning environments while the students are active role players: they read, observe, examine things from different

angles, and try to relate with their previous knowledge, interact with their peers, with their surroundings (their teacher, families, neighbors etc) and acquire the correct concepts. As a result, integrating technology with the student-centred approach may have a better outcome than blended learning.

2.6. Rich learning environment

It is frequently thought that developing countries' education sector is slow in adapting to technological changes. Accordingly, the classrooms are not exposed to technological innovation, even though there is some trail, these countries are still using traditional approaches of teaching. Therefore, the old that depend only on the lecturer and the new, which depend on computer, the lecturer and other related technology, coexist together.

The coexistence of old and new technologies will create inconvenience that will lead remarkable changes in education in the twenty-first century. Combining and integrating the new information technologies with different suitable pedagogies in the classroom would have immense impact on the educational environment (Cope, Staehr & Horan 2002).

Learning can occur everywhere, but the positive learning outcomes generally sought by educational systems happen in well-resourced learning environments. Learning environments are made up of physical, psycho-social and service delivery elements. Therefore, more attention has to be paid to educational processes; how teachers and administrators use inputs to frame meaningful learning experiences for students. Their work represents a key factor in ensuring quality learning processes. As UNICEF (2000) stated the standards by which quality education processed are

- ☞ Environments that are healthy, safe, protective and gender-sensitive, and provide adequate resources and facilities;
- ☞ Processes through which trained teachers use student-centred teaching approaches in well-managed classrooms and schools/higher institutions/ and skilful assessment to facilitate learning and reduce disparities;
- ☞ Outcomes that encompass knowledge, skills and attitudes, and are linked to national goals for education and positive participation in society (UNICEF, 2000).

Various types of technologies have been used in educational environments such as the printed paper, , overhead projectors, filmstrips, films, chalk board and chalk, and other different types of materials for years, and they will also appear in the future as part of the teaching and learning processes. The use of these technologies is very often limited to serve different purposes in instructional and learning activities to a specific place and time, and they have no power to visualize the abstract and complex concepts. However, the emergence of newer forms of technology (e.g., computers, computer discs interactive (CD), videodiscs, DVD, simulation, animation) have created a renewed interest for their use in supporting teaching and learning activities. These technologies are also capable of promoting educational activities (synchronous or asynchronous) which are not confined to specific time and/or place. The adaptation and use of these technologies for instruction and learning is believed to be useful, particularly, because they occur easily throughout the society. Many of the technologies are widely used everywhere and students are expected to be familiar with them before they enter the classroom. Correspondingly, lecturers utilizing these technologies should have to test and ensure the suitability of these technologies for instance the software, CD-ROMS,

compact disc-interactive (CD-I), DVD, hypertext, hypermedia, and multimedia tools whether they are used to enhance the intended classroom activities or not. The vast collection of new technologies now available for learning activities opens new outlooks, engaging students in active learning processes. The appearance of newer forms of technology: the Internet and its resources (e.g., World Wide Web, electronic mail and newsgroups) together with the computer can provide the opportunity to connect different resources and information which are there in different districts and countries of the world that help to create rich and appropriate learning environment (Abdoolatiff, 2009; Duhaney, 2000; Gulińska, 2009; Soika, et al., 2010; Sewall, 2011).

Therefore, the integration of the new technology with appropriate pedagogy makes learning mainly the duty of the student, it has become a co-operative interactive process as students share their ideas increasingly, it enables learning everywhere in the campus, in a society outside the campus as a form of student duty, and as entertainment and home life which makes the learning environment rich and constructive (Duhaney, 2000).

Computer-assisted learning has the ability to provide powerful means to enhance and improve learning, to make invisible lesson understandable as they can represent the multilevel thought in chemistry. This shows that computers have the capacity to support abstract, complex lessons and chemical phenomenon that are not directly perceivable through other means by making clear and understandable. It also provides access to a variety of learning materials and information, which might not readily available to students and lectures within higher institution classroom setting. From the internet, both lecturers and students can explore and download different countries' resources,

experiences without leaving their classroom. The increasing applications of technology to support learning provide a basis by which some lecturers reconsider their strategies they use for instructional activities, prepare the lecturers to identify and employ the suitable one. Different strategies are being employed in conjunction with the more familiar ones to make learning environments rich. The techniques adapted can support the students to play a greater role in the learning process. This occurs, while students become more engaged in determining the sequence and techniques used as well as participating actively in classroom activities. Under their lecturers' guidance students can engage in collaborative learning activities. Together, with their lecturers the students can use different technologies and access information, communicate with others in different geographical locations, and explore new instructional media systems (Asaolu, 2006; Boyd & Ellison, 2007).

Furthermore, when technology is integrated with appropriate pedagogy, it provides clear goals, criticism and advice at every stage, giving the student the opportunity to practice, without personal condemnation, until their learning is no longer difficult. The results are promising. It removes the geographical barrier because the internet, CD and DVD can reach everywhere in the world; it removes the barrier in economic status given that the price of the internet ,CD and DVD is very cheap; it removes the barrier in individual difference since the students learn at their own pace and visual images give the missing clue; it also removes barrier in special needs since, adaptive-technologies-lessons solve many impairments and it encourages lectures elsewhere to try similar methods and possibly perform more systematic evaluations

(Elliton et al., 2005; Kargiban & Siraj, 2009; Mujibul, 2004; O'Neil, Ray & Perez, 2003; Toback, Mershin & Novikov, 2009).

2.6.1. Technology in chemistry learning

“Computer-Assisted Learning” (CAL) refers to the teaching and learning processes supported with a computer. Many educational computer programs are available online, from computer stores and textbook companies. They enhance student learning in several ways. Many chemistry computer programs are inter-active and can illustrate a concept through attractive simulation, animation, sound, and demonstration. They enable students to progress at their own pace and help them to work individually or solve the problems in a group. Computers can provide immediate advice, show the students whether their answer is correct or incorrect and give an opportunity to answer the questions correctly. Computers can provide a different type of activity and learning technique that is different from teacher-centered or pure student-centered approach (Access center, 2007; Kozma & Russel, 2005; Stieff & Wilensky, 2003).

Many computer programs, soft wares' and soft copies can move with the teaching and learning processes at the student's pace, keep them in track and show their progress. Computers have the capacity to capture the students' attention because the designed programs are interesting, interactive and engaging, they can raise the spirit of students' competitiveness in increasing their performance.

The programs also provide differentiated lessons to challenge students who are at risk, average, or gifted. Nowadays, there are a number of Web sites developed by different organizations which make abstractness and complexity of science learning clear and understandable. They are available online such as

<http://www.educyclopedia.be/educationchemistryjava.htm>or

<http://www.chem.iastate.edu/group/grreebowe/sections/projectfolder/smdownload/ind4.html>

Science computer programs illustrate concepts, instruct, and remediate student errors and misunderstandings from primary school through higher institutions. Some programs help students to learn key concepts; others demonstrate how chemicals react, the transfer of electrons and how the structures of substances are formed. Many science textbooks come with interactive CD-ROMs that can be used to reinforce ideas. Computers can provide simulated phenomena, animated interaction and thus make presentations that are intended to be learned by students clearer. It organizes chemistry concepts in agreement with the suitable interpreting and learning approach. As a result, students can be attracted with virtual laboratory studying chemical reactions or observing microscopic phenomena (Access center, 2007). This is very important pre-condition for the actual laboratory chemical phenomena, interpretation and explanation.

Research on learning has shown that students learn better when they construct their own kinds of scientific ideas within the framework of their existing knowledge. To accomplish this process, students must be motivated to actively engage with the content and must be able to learn from that engagement. Interactive computer simulations can meet both of these needs. For instance, Stieff, & Wilensky (2003) reported that simulation, animation and dynamic modeling environments in chemistry learning provide students with the opportunity to observe and explore these interactions that enable them to develop a deeper understanding of chemistry concepts and processes in both the classroom and laboratory.

Moreover, research reports from many countries have demonstrated a positive impact of animations and simulation to make unobservable processes understandable as a technique of visualization (Kozma & Russel, 2005).

This indicates that animation, simulation and video together with appropriate pedagogical approach, may strongly encourage chemistry students' learning by increasing their interest, by clarifying the complex and abstract concepts and by increasing interaction with students, teachers and others. The interaction among different parties and the follow-ups from their teacher help the students to generalize, based on their experiences. The animation, simulation or video enables the students to bring their learning to real life situations. The use of this soft ware may confidentially result in better retention, better understanding of Electrochemistry concepts, and better appreciation of what they have learnt (Access center, 2007; Kozma & Russel, 2005; Soika, et al., 2010; Stieff, & Wilensky, 2003).

Most conventional chemistry lectures as well as the student-centred learning emphasize the symbolic representation such as balancing equations and the macroscopic representation, for instance changes in state, but leave the microscopic representation and dynamic chemical phenomena complex and abstract. Nevertheless, it is possible that computer animations may be used as an effective tool in clearly presenting such complex, abstract and dynamic chemical processes and phenomena at the microscopic and symbolic levels, and so could enhance the student's conceptual change. For example, explaining abstract, complex and dynamic chemical phenomena, such as chemical kinetics, the concept of chemical equilibrium, reaction rates and electrolysis are difficult and time consuming (Talib, Matthews & Secombe, 2005).

Integrating computer technologies into the learning of science is expected to be able to inspire students' experience and facilitate their understanding of abstract, complex concepts of the topic, thus enhancing the understanding of macroscopic and microscopic phenomena in the world of science. Scientific processes presented by means of Computer-Assisted Learning tangibly and visually provide to students clear procedures, concrete ideas and real environments to give them the opportunities to observe the sequences of the chemical phenomena, to organize, comprehend and obtain the true concepts of chemistry (Access center, 2007; Kozma & Russel, 2005; Stieff & Wilensky, 2003; Talib et al., 2005).

Currently, the quality and content of computer technologies, especially the preparation of programs and databases for computer applications such as multimedia products and making of software has improved rapidly and provides a golden opportunity for chemistry educators to utilize Computer-Assisted Learning such as animated, simulated as well as video supporting learning in order to improve the present unclear topics and make them plausible and fruitful learning processes. Thus, through this it is possible to improve students' conceptual understanding. But care should be taken when we design and apply technologies; we should know for what particular purpose they are appropriate. There may be terrible effects such as fear of laboratory and addiction with computer assisting learning (Ferdig, 2006).

Therefore, the process of creating animations, simulation and video in Computer-Assisted Learning chiefly should involve the difficult area of learning, for example process of organizing the movement of atoms, ions and electrons at microscopic levels. The organization of these dynamic and abstract particles provides highly focused, sequence-by-sequence chemical processes which will provide students with

opportunities to directly observe the dynamic motion of chemical processes in the symbolic, macroscopic and microscopic levels, and so assist their conceptual understanding of abstract and complex concepts. For example, in the process of electrolysis, students may see explicitly which electrons are moved and which element is reduced or oxidized (Boudourides, 2003; Strommen & Lincoln, 1992; Talib, et al., 2005).

2.6.2. The Constructivist learning approach

At present, the most popular way of learning is the constructivist approach. The proponents of this theory believe that learning as an active internal process of constructing new conceptions: in which the newly constructed idea should be based on the existing understanding and experience of students. In other cases, the construction of new thought substantially modifies the existing knowledge and improves it into a new, more coherent framework.

This educational philosophy proposes that meaning is not imposed or transmitted by direct instruction rather it is created or constructed by the students' learning activities. This perspective opposes the instructivist (objectivist) outlook of education that believes that knowledge exists independently of the knower and understanding is based on what already exists. The constructivists argue that deep learning will occur only when the student is actively participating in, an operation, or when they mentally process the incoming stimuli. Students acquire knowledge, skill and attitudes actively through a process of active engagement. Almost in all subjects, students doing their work in small groups are likely to learn more of what is taught and retain it longer than when the same

content is presented by other approaches. Students who work in groups also appear more inspired and satisfied with their classes. With this approach, activities will be more prearranged so that group members are mutually supporting each other; each individual is accountable and must participate in the group's activities to succeed (Davis, 1993; John and Staver, 2007; Kanselaar, 2002; Silberman, 1996).

Student-centred learning environments are those that “pay careful attention to the knowledge, skills, attitudes, and with the beliefs that students bring with them to the classroom, where learning as a process “individually construct” meaning based on their prior knowledge and experience. The experiences enable individuals to build mental models or images, which in turn the subsequent experiences together with the incoming idea organized to be a new meaning. Thus, knowledge is not out of the student or independent of the student which the student passively receives; rather knowledge is constructed through an active process by which the student exchange information, constructs hypothesis, and makes decisions using his/her mental models by interacting with each other, teacher, parents, and other community members who help the students to master concepts that they would not be able to understand on their own (Access center 2007; Setzer, 1997; Tinio, 2002).

There are several schools of thought within the constructivist paradigm (Cobb, 1994; Prawat & Floden, 1994). The two most prominent are personal constructivism and social or socio-cultural constructivism. Their major difference was based on the construction of knowledge or meaning. For the personal constructivists, knowledge is constructed in the head of the individual student (Piaget, 1970; Von Glasersfeld, 1989); for the social constructivists, knowledge is constructed with communities' practice

through social interaction (Kuhn, 1996; Vygotsky, 1978). Cobb (1994) argues that the two approaches cannot be separated because both complement each other. For the purpose of this paper, the author supported Cobb's theoretical ideas, representing that knowledge can be constructed through social interaction and conceptualized in the individual student's mind. On the other hand, many researchers reported that traditional classrooms as well as the constructivist approach were using a variety of technologies: such as overhead projectors, radio, periodic table etc but they were not successful in visualizing the abstract and complex lesson.

In contrast to this, the use of digital computers and computer software such as simulation, animation and video that are new in most parts of the world and not practiced by a lot of the countries, if they are integrated with the student centred approach they may play a greater role in solving such problems (So and Kim, 2009).

Knowledge is both individual and shared, and it has to be based on the environment specifically to have a clear vision on abstract and complex concepts; the usual environment must be integrated with a suitable learning environment such as animation, simulation and video. Unless the socially constructed knowledge is being processed in the individual's mind and related to their experiences with the help of suitable environment, it will not be meaningful. Learning environments should support students' active construction of knowledge. Lecturers/Teachers should prepare strategies that help students re-recognize conflicts and inconsistencies in their thinking, as these experiences accelerate the construction of new, more coherent knowledge. Technology-enriched learning environments engage and support students in accomplishing more

complex learning activities with the goal of meaningful learning and conceptual change (Boudourides, 2003; Strommen & Lincoln, 1992).

These are the indicators for pedagogy-based-technology, being an active, ongoing process, situated in multiple contexts, bringing immediacy, interactivity and adaptability. The use of animation, simulation and video in chemistry can be related to the importance of visualizing activities in learning and interactive learning environments that associate constructivist learning with computer applications and allow students to interact with accessible dynamic representations of virtual images. Learning abstract and complex lessons are challenging, which can be helped by dynamic representations (Geo et-al, 2009).

2.7. Pedagogy Based Technology for Chemistry Learning

Pedagogy-based-technology is an integration of pedagogy and content knowledge with technologies such as: computer animation, simulation and video integrated with the student-centred approach.

Due to the fast growth of new techniques and technologies, a strong influence of computer assisted instruction caused the dramatic changes during the last decades. The traditional source of knowledge, the text book, is slowly being pushed behind. At the present time, the use of Computers-Assisted Learning in school as well as in higher institutions is of crucial importance.

The main characteristic of the Computer-Assisted Learning, as opposed to classic teaching materials is that, it presents the learning processes with a combined effect of pictures, sketches, photos, schemes, television, projectors and films. Since it can easily reproduce a number of media simultaneously (sound, tone, motion and

picture), its application in learning chemistry at higher institutions levels is becoming indispensable for a number of reasons. The most effective properties of Computer-Assisted Learning is its ability to make learning individualized in terms of pace and differentiation to fit the learning needs of particular students, it also makes learning open to change both in content and theme to fit the interests of particular students(National Educational Technology Plan Technical Working Group [NETPTWG], 2010).

One of the greatest areas in which technology is of potential benefit in the learning processes is its role to speed up changes in educational pedagogy to create appropriate learning techniques. Research shows that student centred or constructivist approaches in learning lead to better achievement in testing as well as preparing students with the knowledge, skills and attitude necessary in the modern place of work. Moreover, when chemistry learning is supported with appropriate technology such as dynamic picture, simulation, animation, video etc., students show greater co-operation and teamwork, expose themselves for deep learning, develop more confidence, and more willingness to participate in learning activities (Erdamar, 2008).

Thus, the skills of the lecturer/teacher/, coupled with educational technology, enable a better learning and teaching process. With minute professional training in the innovative models of learning, instructional technology can be affordable and sustainable. Students who are exposed to technology integrated with appropriate pedagogy i.e. pedagogy-based-technology outside the classroom in the library, home or elsewhere, may arrive at campus already equipped with some background and motivation, mature with skill, ready for interpretation, collaborative construction of knowledge, that creates the lessons' clarity, instructional variety, engagements in the

learning process and makes the student successful. The subject becomes more sensible and it encourages the student to stay on task (Mohanty, 2007; UNESCO, 2005).

For this reason, as the researchers reported, when students learn with effective mix of learning techniques, it may create in the student' mind a proper image of a concept enabling regular revision of the acquired knowledge and skills, use of all senses to acquire new knowledge, maintain concentration in the learning process, present knowledge in an interesting and attractive way, arouse motivation and thus increasing the quality of learning (Falvo, 2008; Tinio, 2002).

Technology, integrated with appropriate pedagogy, should be planned in order to communicate cognitive and affective changes and must contain genuine, interesting and challenging academic content. It is also important to include true features, because they should help to have fascinating, engaging and meaningful learning to the students.

Successful classroom pedagogically integrated-technology must be engaging enough to persuade the students to put much effort into the world of learning and use their ability. Once motivated, it may be possible to guide students toward self-learning that follows from self-initiated disciplined inquiry to well trained intellectuals (Ferdig, 2006; Kozma & Russel, 2005; Mohanty, 2007; Stieff, & Wilensky, 2003).

Subsequently, technology integrated with pedagogy should create a sense of ownership. Students must have the opportunity to take on a self-regulating role in the learning process, where they understand that they are in control of their learning; they should design, as well as find, the solution of the problem they face. Technology integrated with suitable pedagogy should provide the opportunities for active participation, collaboration and social interaction (i.e. student centred learning). Active

participation is a necessary component of constructivist learning theories and thus, it is also a major principle of those theories that support a social perspective of learning.

Research reports suggest that when students collaborate, they can adjust their learning path for each other's thinking and examine things from various directions. This is an extremely important point, because for the most part, students enjoy learning more when they interact with their peers than with adults (Ferdig, 2006; Kozma & Russel, 2005; Stieff, & Wilensky, 2003).

Finally, pedagogically organized technology must give opportunities for the creation of learning processes in a variety of ways. The creation of learning processes allows students to learn concepts, apply information and represent knowledge in different ways. Those learning processes, in turn, represent students' understanding of the problem, resulting solutions and come into view with better skill and knowledge (Abdoolatiff, 2009; Gulińska, 2009; Mork, 2005; Soika, et al, 2010; Sewall, 2011).

Computers Assisted Learning may influence learning interactions in four ways in the classroom:

- 1) Interactions with computers may increase a team quality where two or more students gather at a particular place to solve a problem together.
- 2) Information exchange with computers. In this case, when computers are in a separate place and joined by modem they facilitate the exchange of information. These kinds of interactions are more casual and improvised exchange.
- 3) Computers also enable participants who are in different places to interact. If the partners are separated in time and space but networked and if they have internet access the computer can create opportunity for partners to share experience.

4) Interactions may occur by using computer software application.

The focus here is on certain circumstances where the crucial feature of the computer's mediation is required such as when the lesson is complex and abstract; it is possible to share ideas using appropriate software application (Mork, 2005).

This study assumes that applying technological integration through the whole lesson of chemistry learning is unnecessary, since it reduces the creativity of students, reduces the interaction of students with the apparatus, scientific procedures and reduces self-confidence to deal with chemical processes in the laboratory which is the source of many scientific foundations. Therefore, the lecturers should be careful when they organize their plan; they should selectively focus on the student's difficulty such as complexity and abstract nature of lessons. Technologies are not inherently good or bad.

It is the pedagogy and personnel that determine the significance, quality and impact of the creation, implementation and subsequent use. However, there are times when technologies may possess features that make them more or less conducive to learning (Ferdig, 2006). On the other hand, the learning environment should be interactive and participatory: when students work together, they can correct their mistakes by thinking, examining things from different angles; relating from their real experience and being acquainted with. This is an extremely significant point, because for the most part, students spend far more time in direct interaction with their partners than they do with lecturers and assimilate the intended concepts of the lesson. So it is useful to utilize aspects from a socio-cultural, as well as an individual view of learning to make learning understandable in chemistry. It is insufficient to focus only on students' "mental structures" to explain how students learn in chemistry classrooms; hence

consideration of the social environment through which students encounter scientific ideas is also necessary (Mork, 2005; Ferdig, 2006). In order to have successful PBT learning environment and effective students performance the cooperation of all university's society the university's vision, mission, visualizing software, the students and the lecture are very important as shown in the figure bellow.

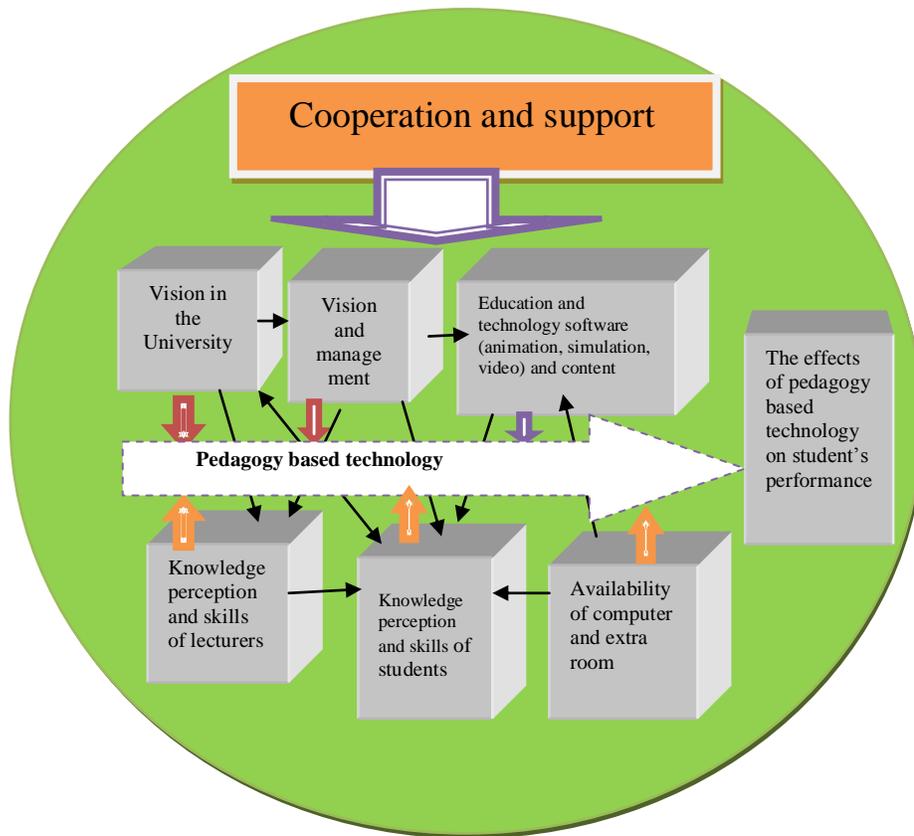


Figure 1: Conceptual framework

2.8. Challenges to Integrate the Computer-Assisted Technology with the Appropriate Pedagogy

Although the application of technology in the classroom has many benefits, there are also clear drawbacks. For instance limited access to sufficient quantities of technology, and the extra time required for the installation and implementations of technologies and lack of mini training are some of the reasons why technology is often not used extensively in the classroom (National Council of Educational Research and Training [NCERT], 2006).

Minute training is vital to ensure the effective integration of classroom technology. Technology is not an end by itself, but rather a means by which educational processes can be enhanced. Therefore, educators must have a good proficiency in the technology being used and its advantages. If there is inadequacy in training of technology, technology will be seen as a hindrance and not a benefit to the goals of learning (NCERT, 2006; Varank, 2009).

Another difficulty is the insufficient quantity of resources. This often occurs when the quantity of computers or digital cameras for the classroom use is not enough to meet the needs of an entire classroom. The other challenge to implement the integration of technology is limited access for technology exploration because of the absence of computer and internet, and the fear of damage. On the other hand, the inconvenience of resource placement is also a hindrance, such as having to transport a class to a computer lab instead of having in-classroom computer access by means of technology for example classroom equipped with computer.

Technology implementation can also be time consuming. There may be an initial setup or training, time and cost inherent in the use of certain technologies. Even after these tasks have been accomplished, technology failure may occur during the activity; as a result lecturers must have an alternative lesson ready. Another major issue arises because of the dynamic nature of technology. New resources have to be designed and distributed whenever the technological platform has been changed. Finding quality materials to support classroom objectives after such changes is often difficult even after they exist there may be insufficient quantities and thus, it may require lecturers to design these resources on their own (Varank, 2009).

2.9. Summary

Review of literature research in this section shows that many concepts and phenomena of chemistry which can only be understood and communicated through the use of chemical representations are abstract and complex (Hilton, et al., 2010) but the chemistry students find difficult to visualize conceptual models such as dissolving, electron transfer, ion conduction, inter molecular and intra molecular bonding as well as the dynamic chemical phenomena that are fundamental for chemistry learning at the university level (Gupta-Bhowon et al., 2009; Simsek, 2009). There are level1, level2, level3 and level4 sources of difficulty during the process of Electrochemistry learning (Grayson, Anderson & Crossley, 2001). For most students the source of difficulty in learning chemistry is the abstract nature and complexity of the chemistry lesson (Gupta-Bhowon et al., 2009; Simsek, 2009; Tsaparlis, 2003), which requires a consistent appropriate learning technique supported with suitable learning environments.

There are some research that have been done on chemistry learning examining students' knowledge and misconceptions focusing on some microscopic content area: such as atomic structure and bonding (Abdoolatiff, 2009), mastering Chemistry (Arasasingham, 2005), ionic nomenclature (Chimeno et al., 2006), theoretical concept of chemistry (Gupta-Bhowon, 2009), molecules and molecular models (Falvo, 2008; Wu, Hsin-Kai, Joseph & Elliot, 2001), software, CD and DVD to reduce risk in experiment (Gulińska, 2009), theoretical concept of chemistry (Gupta-Bhowon, 2009), chemical reaction in laboratory (Kennepohl, 2001), structure of substances (Kozma & Russell, 2005), ICT in Science education (Mork, 2005) and chemical equilibrium (Stieff & Wilensky, 2003). Even though these reports were not focusing *particularly* on abstract and complex concepts of chemistry, they have clues for which integrating suitable technology with appropriate learning techniques would have a capability to make the abstract and complex concepts of chemistry clear.

In chemistry learning, it is important for chemistry instructors to realize how abstract and complex concepts in their teaching influence students' development of understanding, as well as to recognize essential concepts that bridge students' understanding to the next level. Thus, there is a need for research to extend the area of investigation to examine students' difficulty that helps them construct their own concept in order to reveal relationships between and among related concepts and their impact on student learning. Missing these concepts or linkages among conceptions, incorrect understanding, or fragmented conceptions may result in failure in learning.

This paper study assumed that Computer assisted learning can help to visualize abstract and complex lessons of chemistry. Computer assisted learning has a relatively short

history in the educational system, but its rapid progress in line with students difficulty is important to know how they influence learning. From the first introduction of Computer assisted learning in schools in the late 1970s and the early 1980s up to now, it has done a lot to improve the learning processes (Access center 2007; Soika, et al., 2010).

Science and technology are moving ahead faster than ever before. The 'information age' is here. In many disciplines and occupations, what is known becomes outdated quicker than the knowledge can be learned. Hence, the use of latest technology is the best system for quality learning.

Nowadays, the constructivist/student-centred/ way of learning is the most popular to acquire lifelong knowledge. Therefore, integrating appropriate student-centred strategy with suitable technology such as animation, simulation and video according to their importance can help to make clear the learning processes.

The main characteristic of the computer assisted learning, as opposed to classic teaching aids, is the fact that it unites: the use of picture, sketch, photo, scheme, television, projectors and films since it can easily reproduce a number of media simultaneously (sound, tone, motion and picture). Its application in teaching chemistry at higher institutions levels is becoming indispensable for a number of reasons. Students have a back ground of computer knowledge; they are focused and overcome the problem of understanding abstract nature and complexity of concepts. Computer can go with students' pace and fit the differentiated learning needs of students and it can be arranged in contents or theme to fit the interests of particular student (NETPTWG, 2010).

Thus, the skills of the lectures/ teachers coupled with educational technology help to have better learning processes. Without substantial and extended professional

development in the innovative models of learning and teaching, the instructional technology can be affordable and sustainable. Students exposed to technology integrated with appropriate pedagogy i.e. pedagogy-based-technology outside the classroom in the library, home or elsewhere, may arrive at campus already prepared with some background and motivation. It enables them to be ripe for guided inquiry, ready for interpretation, collaborative construction of knowledge, which creates the lessons' clarity, instructional variety engagements in the learning and teaching process and makes the student successful. The discipline becomes more practical and it can make interesting students learning (Mohanty, 2007; UNESCO, 2005).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter encompasses the research methodology, the research design, the research method, variables, the population, sample and sampling procedure, data gathering instruments, validity and reliability of instruments, data collection and method of data analysis.

3.2. Research Design

Under the pragmatic paradigm, the researcher used the sequential embedded mixed research (quasi experimental and Explanatory) case study design to investigate the effect and use of animation, simulation and video, integrated with the student-centred approach compared to the usual student-centred approach in learning electrochemistry.

Pragmatism is a philosophy that has been developed, popularized and associated with two early American philosophical representatives John Dewey 1859-1952 and George Herbert Mead 1863-1931 (Dewey, 1960; James, 1977; Mead, 1981; Peirce, 1992). Different from other philosophical approaches pragmatism focused on “what works” it has no argument supporting either positivist or constructivist i.e. whether a research is clarifying a real or socially constructed world. For pragmatism a research is simply work or finding which helps people to do things they need or findings that enables people to solve problems. According to them a good theory is one that helps people to reach a specific goal or set of goals or one that reduces our uncertainty about

the outcome of a given action (Halton, 2004; Peterson & West, 2003). Most pragmatic researchers use a 'mixed-methods' approach to a research; namely qualitative and quantitative methods to answer their research questions. Pragmatic researchers have used the quantitative and qualitative methods in creative ways to more fully answer research questions. They have used it sequentially embedded or concurrent embedded. Campbell and Fiske (1959) were the first researchers to introduce the notion of using both qualitative and quantitative techniques to study the same phenomena. In current researches, the pragmatic philosophical approach is used by both professional researchers and researchers who are primarily practitioners involving teachers, counselors, administrators, and school psychologists (Bacon, 2009; Halton, 2004; Peterson & West, 2003). In accordance with pragmatic philosophy the research methodologies are not essentially positivist or constructivist rather they are research studies designed that can combine the quantitative and qualitative information of a research on data collection or on data analysis stage (Onwuegbuzie & Leech, 2004; Onwuegbuzie & Leech, 2006). And this philosophy has shown the importance of integrating methods when it is appropriate.

The concept of mixed research has been used for more than four decades in different names such as multiple or mixed approaches, mixed methods, multiple methods, integrated methods, mixed models, multiple models, qualitative plus quantitative approaches, and combined qualitative and quantitative methods. Mixed research perhaps can be taken as a modern term (Creswell & Plano, 2007; Johnson & Onwuegbuzie, 2004). Researchers are now able to test and are able to employ deductive

and inductive analysis in the same research study showing the implementation of mixed research.

Mixed research design is a very important design that can provide researchers with the ability to design a single research study that answers both the complex nature of phenomenon from the participant's point of view with the relationship between measurable variables. The supporter of the mixed research approach advocates, employing the mixed research within the principle of research helps to investigate, to predict, to explore, to describe, and to understand the phenomenon (Creswell, 2007; Johnson & Onwuegbuzie, 2004; Onwuegbuzie & Collins, 2007; Tashakkori & Teddlie, 2003).

Therefore, mixed research designs enable us to collect, analyze, and mix both quantitative and qualitative outlooks of participants or data in the same study (Tashakkori & Teddlie, 2003).

The use of quantitative and qualitative approaches in combination:

- Provides strengths that counterbalance the weaknesses of both quantitative and qualitative research. There has been the historical argument for 25 years. The argument was that quantitative research is weak in encompassing the context or setting in which people discuss. In addition, in quantitative research there is no system in which the participants' voice is heard. But qualitative research reduces these weaknesses. On the other hand, qualitative researches have a number of limitations as of the personal interpretations made by the researcher; there is chance for formation of bias, and the difficulty in generalizing findings to a large group because of the limited number of participants studied. However,

quantitative research solves such type of weakness (Brannen, 2005).

- Provides more comprehensive evidence for studying a research problem than quantitative or qualitative research alone. To collect full information researchers are free to employ both qualitative and quantitative research methods in a mixed manner (Creswell, 2006; Tashakkori & Teddlie, 2003).
- Helps to answer questions that cannot be answered by qualitative or quantitative approaches alone. For example, participant views from focused group discussion and from post test result converge as a mixed methods question.
- Encourages the use of multiple worldviews or paradigms rather than the typical association to a certain paradigms for example to quantitative researchers and others to qualitative researchers. It also encourages the present investigator to think about a paradigm that might encompass all of quantitative and qualitative research (Creswell & Plano, 2007).
- It is “practical” in the sense that the researcher is free to use all methods appropriate to address a research problem. It is also practical” in the sense that individuals tend to solve problems using both numbers and words, as well as by combining inductive and deductive thinking
- It is usual, for individuals to employ mixed method researches as the better mode of understanding the world. For example, when people talk about the Katrina devastation in the southern United States, both words and numbers come to mind. This type of talk is not only more usual, it is also more persuasive than either words or numbers by themselves in providing a complete picture of the devastation (Johnson & Onwuegbuzie, 2004).

It helps us to think all the possibilities and provides the opportunities for a greater assortment of divergent views. Triangulation, including diverse sources of data, for the same case gives comprehensive and full information, facilitates the richness of data and to expand the interpretation of the findings (Andrad, 2009; Collins, Onwuegbuzie, & Sutton, 2006; Creswell, 2006; Creswell & Plano, 2007; Johnson, 2006; Johnson & Christensen, 2004; Mason, 2006; Onwuegbuzie & Leech, 2004; Ritchie, 2003; Tashakkori & Teddlie, 2003).

Many researches are based on the quantitative result such as technical effectiveness and performance measurement. Such study may only treat organizational context, technological features and user applications as static and objective rather than dynamic and interacting natural phenomena. These studies were focused on the static constructs, but they neglect the aspects of social interaction that may influence outcomes (Andrad, 2009). With respect to organizational structures etc, and in these studies, animation, simulation and video are viewed as 'impact' rather than a social construct.

On the other hand, employing animation, simulation and video in the qualitative research aspects with the social context, enables participants to explain the animation, simulation and video in terms of social action and used to improve the perception toward visualization to envisage clear meanings, increase interaction which leads to better conceptualization and results in improved constructs of learning (Klein & Myers, 1999).

Therefore, mixed research design helps the present investigator to 'think outside of the box', to theorize beyond the micro-macro divide, and to enhance and extend the logic of qualitative explanations (Mason, 2006).

Each of these two approaches provides a distinctive kind of evidence and when used together they can offer a powerful resource to inform and clarify practices (Ritchie, 2003). This research combines the quantitative and qualitative data collection at the analysis stage for the reason that, quantitative data can indicate relationships which may not be noticeable to the researcher. Besides this, qualitative data provides knowledge that comes from dynamic interaction of social processes, change and social context so that it can answer ‘how’ and ‘why’ questions which support the quantitative data (Eisenhardt, 1989; Mason, 2006).

As a result, these techniques can provide comprehensive data on the role and the effect of animation, simulation and video in relation to student centred method of learning, and reflect a range of perceptions from description of focus group discussion and quantitative presentation to gain a fuller picture of the phenomenon under study. In view of the fact that, triangulation, including diverse sources of data, for the same case gives comprehensive and full information (Denzin, 1978). Based on the information given above, the data in this research was collected mainly by adopting quasi-experiment employing the processing of animation, simulation and video integrated with student-centred learning, which comprise richer descriptions of phenomenon and supporting the information obtained by quasi experiment and survey the qualitative open-ended schedule and focus group discussion from different participants in the college of Natural Science of Debre Berhan University to obtain comprehensive information were used.

3.2.1. Quasi- experimental and case study

Quasi experimental and the explanatory approaches helps the researcher to explain conditions and the effect that exists; practices that prevail, beliefs, points of view or attitude that are held, the processes that are going on, effects that are being felt, trends that are developing. Or it enables the researcher to illustrate, how, what is or what exists in relation to the preceding event that has influenced or affected a present condition or event (Best, 1988).

3.2.1.1. Quasi-experiment

Quasi- experiment is an experimental study that does not involve randomly assigning participants to treatment and control groups. It can be used when it is impossible to control variables; particularly in cases the participants cannot be randomly assigned to the groups to examine the outcomes. A quasi-experimental study can compare performances of students receiving the intervention activities with the performance for a similar group of individuals not receiving the same programme or activities.

Quasi-experimental design can provide

- ☞ Explanatory information on who is being served by animation, simulation and video. It also explains whether the learning technique is truly advantageous for university students or not (Hansen, 2007).
- ☞ Information that suggests whether anticipated changes are occurring: - based on a PBT's logic the learning process expected to improve the performances of the students. If this is effective over time, PBT investigator can confirm that

expected changes are happening. If that is not the case, this situation signals a need to look deeper and identify factors that may hinder the anticipated changes from actually happening (Shadish, Cook & Campbell, 2000).

- ☞ Data that suggest the magnitude of change that is occurring over time:-PBT provider and researcher hope for changes that university students will be benefited from. The expectations may be too high comparing to the time and activities involved in a programme. Nevertheless, it is important to explore using the collected data whether changes are small, medium, or large, in relation to the information obtained with PBT compared to changes resulting from student centred approach (Reed & Rogers, 1999).
- ☞ Information on whether anticipated changes are occurring in some sub-groups and not others: - Programme evaluations often find that programmes are more successful for some sub-populations than for others. It is helpful to identify whether results are fruitful for some groups than the others; therefore, quasi experimental design enables us to compare to what extent PBT affects the student in comparison to the student centred techniques of learning (Gall, Gall & Borg, 2007).

Many circumstances call for serious consideration of a quasi-experimental approach.

The reason why quasi-experimental study was used:-

- ☞ On account of random assignment, it was not feasible at the selected university. This research was conducted in Debre Berhan University on second year chemistry students, with students who have different ability, age, sex and

learning exposure, with it was impossible to randomly assign participants to treatment and control groups. Therefore, a quasi-experimental study was suitable.

☞ In view of the fact that, it is impossible to avoid “contamination” of the control group. The intervention was carried out in the same university in which students have a day to day contact; it is not possible to keep students in the control group from being affected by the treatment group. The students in the treatment group may talk to students in the control group about the program during lunch time or other times, so the control group is also being influenced by the treatment (William & Pearce, 2006).

In sum, when a random assignment is not feasible or when experimental design not suitable to conduct, the quasi-experimental design is preferable (Moor, 2008).

Figure 2: Representation of study quasi experimental design

Group	Pre test measure	Intervention or Technology (Animation ,simulation and video)	post test measure
Treatment X_o	X _{O1}	☒	X _{O2}
Control X_c	X _{c1}	☐	X _{c2}

2 X 3 X 2 - matrix

X_o = treatment group (pre test)

X_c = the control group (pre test)

☒ = treatment

☐ = control

X_{o1} = pre test measure for treatment group

X_{o2} = post test measure for treatment group

X_{c1} = pre test measure for control group

X_{c2} = post test measure for control group

The dash line indicates non random assignment to comparison group.

3.2.1.2. Case study

This research was conducted through three instruments or methods: - tests, schedule and focus group discussion for the reason that case study is a design when a holistic details investigation is needed. For events occurred in group or community by gathering data with multiple methods from a variety of sources demonstrate by means of widespread explanation, and analysis of that data taken as a whole and in its context about a complex phenomena occurred to obtain a thoughtful facts or knowledge (Kayrooz & Trevitt, 2006; Yin, 1994). The researcher considers not only the voice and response of the actors, but also of the relevant groups of actors and the interaction among them and the information gathered by various instruments (Tellis, 1997). It is very important to explain complex causal links in real-life interventions, to explain the real-life context in which the intervention has occurred, to demonstrate the intervention itself and to explain those situations in which the intervention has no influence (Gerlich, 2009). It is also important for triangulation to combine methodologies in the study of the same phenomenon. It is a design for establishing the truth of information by comparing three or more types of independent facts provided by the data sources (for example, interviews, focused group discussion observation, and documentation) present on the same findings (Gerlich, 2009; Stake, 1995; Tellis, 1997; Yin, 1994).

Variables

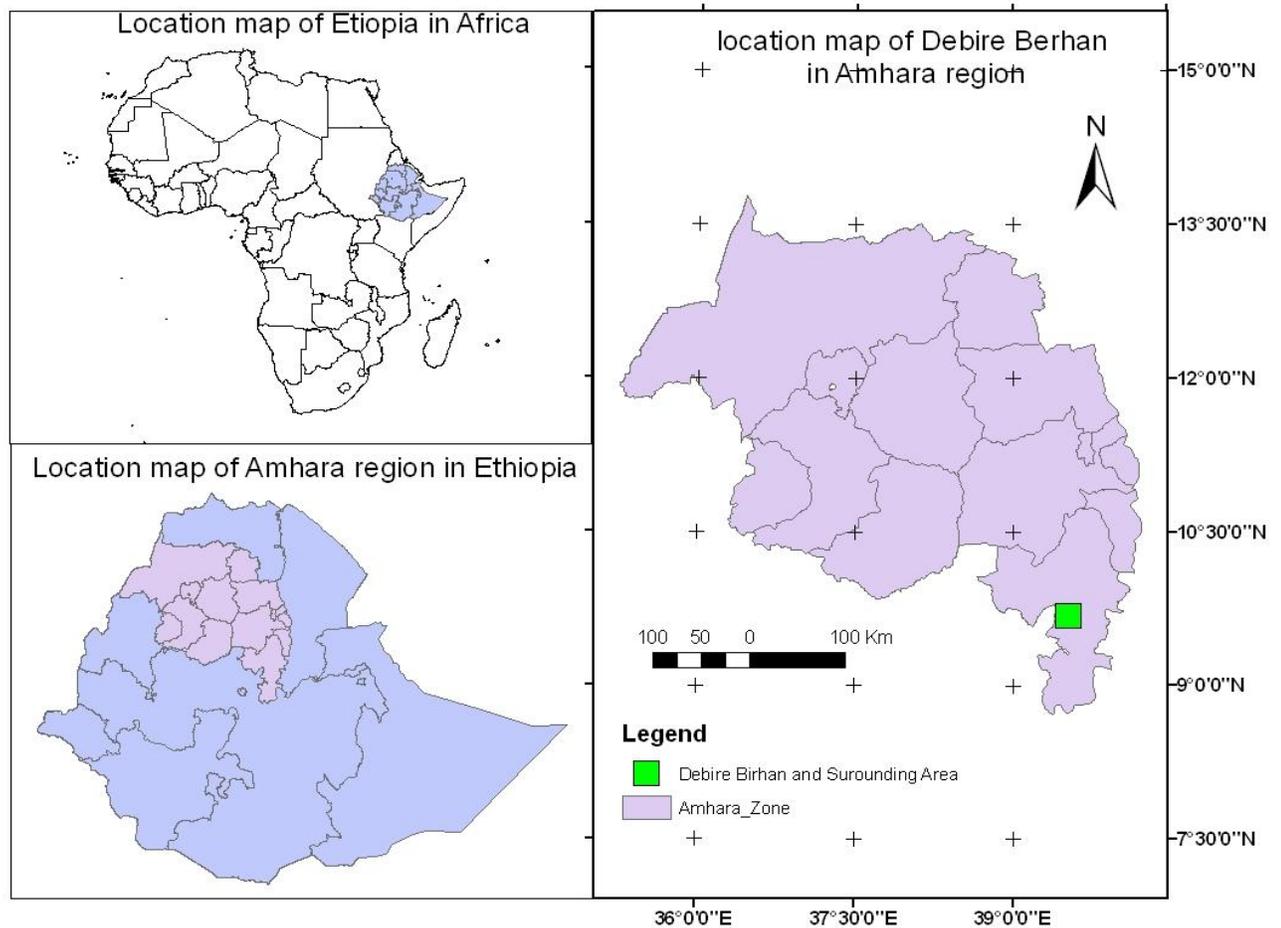
The independent variable in this research was pedagogy-based-technology, Electrochemistry and the dependent variable is students' performance.

3.3. Population of the study

The chemistry program under the College of Natural and Computational Science with 14 lecturers is one of the twenty two programs which have a total of 303 students of whom 120 are second year chemistry students.

The population of this study was 120 2nd year chemistry students and 14 chemistry lecturers of Debre Berhan University. Second year students were selected because first year students were busy with other courses and only study chemistry at the end of the academic year. Third year students were graduate students and they would give no attention to tests nor properly fill the questionnaires which affect the result of the study.

Figure 3: The location map of the research area



3.4. Samples of the study

After we have discussed the objectives of the research and convincing the students that the teaching learning process reversed after the data gathering processes completed. 12 teachers, 45 control and 45 treatment groups who are registered with their interest voluntarily were participated. Which was convenient nonequivalent sampling system in that no equal distribution of male and female and no randomization).

With this sampling technique a sample size of 90 second year Debre Berhan University chemistry students were selected: from a total number of 120 students which is 75% (45 for treatment and 45 for control group) and 12 from a total number of 14 lecturers were selected that is 85.7%. The samples were nonequivalent control and treatment groups in nature as is most commonly used in quasi-experimental design in educational research and the students were trained with application and the operation of software of Electrochemistry for 15 days.

The participants selected with the intention that conveniently selected samples provide useful information and students who had exposed to computers personally and in small computer equipped room constituted the treatment group.

All participant students were enrolled in the second semester of the Electrochemistry course, during the academic year of 2010/2011. Students who agreed to participate, in this study signed in the participant consent form (see Appendix A). 15.6% of the participants were female and 84.4% were male. From the total sample of 90 voluntarily participated 24 of them again participated in the focus group discussion. In order to stimulate participation, pocket money 230 birr was given for each student. All 12 lecturers (100%) were male. Their mean years of teaching experience was 6.33 years (SD = 4.1) in the range of the minimum 2 and maximum 16 years. From the total samples of 12 voluntarily participated 8 of them again participated in the focus group discussion.

3.4.1. Controlling effect of possible contamination

1. With the current Ethiopia situation the students have no access to computer outside the prepared classroom. Students with access to computers formed the treatment group

and any possible interaction between the groups would not benefit the control group given that treatment required use of computers. Furthermore, computer use was not needed in the control group. Therefore, any knowledge or skill acquired during possible interactions between students of treatment and control groups would not benefit the control group.

2. Four student facilitators and supervisors were also selected among the sample students who organized the students and monitored information dissemination.

3.4.2. Creating opportunity to have the same exposure of the program

To create equal opportunity and exposure of the program, in a similar manner, the control group the investigator was provided them same treatment after the data has been collected, which helps them to have the same pleasure, skill and knowledge of the course like the experimental group.

3.5. Data Gathering Instruments

The research was conducted using the test, schedule: a type of questionnaire in which the investigator or trained person distributes and gives explanation when it is necessary and collects the questionnaire immediately by attending the data collection, and focused group discussion methods or instruments. This allowed the researcher to investigate the effects of PBT on students' performance in the sample university.

3.5. 1. Test

The pre and post test containing 13 multiple choices and six short answer questions were given to all students to see if there is any difference in scores between the control and treatment groups. Tests are forms of measuring device that can add to

awareness about something thereby enable us to make more informed choice. It is a reliable and valid gauge that has a capacity to measure the same characteristic in the same way (Barret, 2008). Test can be designed to measure potential for achievement and can be used to yield valid inferences about achievement for all trainees (Elliott, Kettler, Beddow & Kurz, 2011).

3.5. 2. Schedule questionnaire

Schedule questionnaire is very important to gather much information from many respondents in a relatively short period of time and allows respondents to respond freely, exercise less pressure from immediate responses as the interview (Kayrooz & Trevit, 2006). It can ensure their confidentiality and gives them time to think from different perspectives before responding. Specifically schedule enables the researcher to collect papers in a timely manner. It is reliable in most cases and can be used to gather standardized data quickly from a large number of respondents it is therefore easy to analyze (Kayrooz & Trevit, 2006; Pallant, 2005).

For this reason, schedule questionnaires were prepared by the researcher; for the college head, students and teachers to examine their awareness, perception and activities of the respondents. Furthermore, they helped to check to what extent pedagogy-based-technology is useful in Debre Berhan University. They were prepared in order to have both open and closed ended questions enabling respondents to freely express their ideas, feelings and opinions.

Measuring the perception of human beings is found in many areas including the social and natural sciences; there are a number of different measuring instruments that have been designed to assess perception of human beings. However, Likert scale is a

subject-centered approach used to measure participants' view or opinion with five degree of agreement/disagreement such as strongly agrees, agree, have no idea, disagree and strongly agree with the item raised in the schedule. It is a type of psychometric rating scale often used in questionnaires or schedule, and is the most widely used scale in survey research. When responding to a Likert in questionnaire/schedule item, respondents specify their level of agreement to a statement (Likert, 1932). The Likert scale was used in collecting the data with schedule responses across different questions in each case simply it indicates how they agree positively or negatively.

3.5. 3. Focused group discussion

A focused group discussion with seven open-ended questions was prepared and conducted for three groups of students and one group of lecturers each containing eight participants. The intention was to find out: - their perception, awareness and the suitability of the university environment in relation to their activities. In addition, it was to see what difficulties students face while learning chemistry and what their feelings look like concerning animation, simulation and video in learning chemistry(Campbell, 2008; Hart, 2009; Wong, 2008). A focus group discussion is a rapid assessment, structured data gathering instrument in which the participants purposefully selected meet to discuss issues and concerns based on a list of key themes prepared by the researcher/facilitator (Kumar, 1987). The focus group discussion is chiefly important for the reason that it provides a fast way to obtain knowledge from the target interviewee and is effective for accessing a broad range of outlook on a specific topic (Hart, 2009; Krueger, 1997).

It helps the researcher to be acquainted with social norms of a community or subgroup, as well as the range of point of view that exist within that group of people or sub-group, used to identify what service or product a particular population wants or would like to have. The focus group helps to obtain richer data from the groups' interaction based on the given them or points, it allow participants to react from different angles; they influence each other through their presence, their experience and their reactions to what other people say and come into consensus with one important idea (Campbell, 2008; Hart, 2009; Kruger, 1988; 1997; Oates, 2002; Wong, 2008).

3.6. Validity and reliability

3.6.1. Validity of the instruments used

Validity is evidence accumulated to provide a scientific base for the proposed interpretation of the test scores. Accordingly, before providing the tests, distributing the schedule and focused group discussion questions, the researcher submitted them to his advisors and experts, for their critiques and comments that subsequently led to some rearrangement (appendix K) to ensure a high level of validity. The content validity index of the schedule for both lecturer and students similarly was **0.79** whereas the content validity index of the test was **0.81**. The content validity of the Schedule, and focus group questions were established in which four experts in the field of education, educational psychology and three experts in the field of physical chemistry were consulted in the course of developing the instrument items. They finally conclude that the instruments items were properly classified as explanatory of PBT and constructivist learning techniques (Golafshani, 2003; Tashakkori & Tedlie, 2006).

3.6.2. Reliability

The Cronbach's Alpha was used as indicators of internal consistency and to describe the strength and direction of the linear relationship between the dimensions of each instrument. This study was explanatory in nature to lay a foundation for focusing on the more specific features of PBT. Prior to distributing the instruments, which were prepared in the English language, the researcher collected data from the home university by taking 3 randomly selected teachers and 12 students that were not included in the sample, as *a pilot test (see appendix N)* and its reliability was checked with Cronbach's Alpha. Cronbach Alpha is an important tool to determine the reliability of instruments by calculating a reliability estimate (Brown, 1998; Brown, 2001; Cronbach, 1970). The schedule for students and lecturers Cronbach's Alpha value were **.83** and **.94** respectively.

A Cronbach Alpha estimate (often symbolized by the lower case Greek letter α) should be interpreted just like other internal consistency estimate, namely, it estimates the proportion of variance in the test scores that can be attributed to true score variance. It is used to estimate the proportion of variance that is systematic or consistent in a set of test scores. It can range from 00.0 (if no variance is consistent) to 1.00 (if all variance is consistent) with all values between 00.0 and 1.00 also being possible. For example, if the Cronbach alpha for a set of scores turns out to be .80, one can interpret that the test is 80% reliable and that it is 20% unreliable (100% - 80% = 20%). Therefore, it is a useful and flexible tool that can be used to investigate the reliability of test results and instruments (Brown, 2002). Thus, 0.83 is 83% reliable and 0.94 is 94% reliable respectively.

3.7. Data Collection and Research Procedure

After selecting the students, they were grouped into treatment and control groups which comprise 90 students of chemistry department of College of Natural Science in Debre Berhan University, each group containing 45 students, thus the control and treatment groups were formed; to assess their existing knowledge about Electrochemistry, the pre test was given. Secondly, the computer-assisted chemistry education employed through the same abstract and complex lesson for the treatment group using simulation, animation and video in a small room equipped with computer by the researcher. And the control group was taught with the usual student centred technique of learning at the same time using the same status teacher planned to observe any difference between control and treatment group learning with PBT. The quantitative aspect of the study involved the quasi experiment for six weeks: - each week having three periods of 50 minutes for each period for both treatment and control group.

The contents of the lessons are

Introduction (three periods)

- ◆ Definition of electrochemistry and use
- ◆ Conductivity
- ◆ Redox reaction
- ◆ Reduction
- ◆ Oxidation
- ◆ Voltaic or galvanic cell
- ◆ Electrodes and electrode reaction
- ◆ Terms like anode, cathode and salt bridge.

- ◆ Cell diagram notation

2. Electrolytic cell and electrodes (*six periods*)

- Definition of electrolysis
- Electrolysis of substances (acids, bases and salts) in aqueous solution
- Coulomb's law
- Faradays law of electrolysis

3. Cell Potential and Thermodynamics (*six periods*)

- ✓ Potential difference
- ✓ Activity series
- ✓ Reduction potentials
- ✓ Standard cell half cell potentials
- ✓ Cell potential and free energy
- ✓ Thermodynamics and galvanic cell

4. Nernst Equation (*three periods*)

- Significance of Nernst equation
- Cell potential and concentration
- Cell potential and pH
- Concentration cell

Thirdly, the same Chemistry Performance Test was administered as a post test and the changes in the performance rate were checked. Both groups took the Chemistry Performance Test as the pre and post test of the study. Fourthly, the schedule was distributed for the College Dean, department head, sampled lecturers and students on their places of work to complete the schedule which took 40 minutes. Participants were

told that the schedule had to be returned no later than 50 minutes after the distribution. Only schedule returned within the given period were considered as valid source data. All schedule instruments were personally distributed and collected to ensure timely return of data from those who chose to participate. This method made the return rates faster than traditional questionnaires by eliminating the need for participants to return the completed schedule using the postal system subsequently, the investigator conducted focused group discussion with students first and with lecturer second on the following day by organizing participants using facilitators.

. The quantitative data was then entered into the SPSS 18 PASW computer programme to assist in the analysis of the data.

3.8. Method of Data Analysis

3.8.1. Quantitative analysis

After collecting and tabulating the data, the researcher used independent t-test since they have their own independent knowledge before taking pre-test and paired sample t-test to compare their score performance and ANCOVA to analyze and interpret the collected data.

1. Analysis of Covariance

Analysis of Covariance (ANCOVA) is a statistical control method that is used to statistically equate groups that differ on a pretest or some other variable. For example, in learning research study to control for intelligence because if there are higher achiever students in one of two comparison groups the difference between the groups might be mental power difference rather than the treatment variable that needs control. Analysis of

covariance gives a means of statistically controlling the (linear) effect of variables one does not want to examine in a study. These extraneous variables are called covariates, or control variables. ANCOVA enable to get rid of the effect of covariates from the list of possible explanations of variance in the dependent variable using statistical techniques rather than direct experimental methods to control extraneous variables. It is also used to adjust statistically the dependent variable scores for the differences that exist on an extraneous variable. The purpose of using the pretest scores as a covariate in ANCOVA with a pre-test-post-test design is to (a) to reduce the error variance and (b) to eliminate systematic bias. Therefore, ANCOVA is used to adjust the post-test means for differences among groups on the pre-test, because such differences are likely to occur within intact groups. It is also important when pretest scores are not reliable, the treatment effects can be critically biased in nonrandomized designs.

When there is no linear relationship between pretest and post test and when the homogeneity of regression slope is different the use of ANCOVA is important. Another advantage of ANCOVA is that it extends to include a quadratic or cubic component or, when the regression slopes are not equal. Accordingly, the ANCOVA was used to analyze the tests since it enables us to reduce contamination and covariates. It "*adjusts*" post-test scores for variability on the covariate (pre-test) and that it enables us to adjust the effects of one variable on another and the different levels of awareness among 2nd year students using SPSS 18 PASW statistical software (Dimitrov & Rumrill, 2003; Evert, 2001; Koul 1984; Wright, 2008).

2. T test

The *t*-test is one of the most widely used statistical procedures. It comes in three basic varieties: the single-sample *t*-test, the two-sample *t*-test, and the paired sample *t*-

test. Specifically paired sample t-test is essential when it is required to compare the educational level of the participants measured before and after treatments (Moore & McCabe, 2006; Watkins, Scheaffer & Cobb, 2004).

3.8.2. Qualitative Analysis

The qualitative data was analyzed using Thematic Content Analysis technique (Gray, 2004). This means that after categorizing the responses with four categories taking those ideas which are most frequently given by the respondents as important data to analyze the information. Thematic Content Analysis can be used to analyze various types of data, by transforming the data into written text and individual themes as the unit of analysis. The information of a theme might be expressed in a single word, a phrase, a sentence, a paragraph, or an entire document (Buber, Gadner & Richards, 2004; Creswell, Shope, Plano & Green, 2006; Minichiello, Aroni, Timewell & Alexander, 1990).

Thematic Content Analysis (TCA) is explanatory presentation of qualitative data. The qualitative data can be collected by using interview, focused discussion and open-ended survey questions from research participants or other identified texts that reflect experientially on the topic of study. Thematic Analysis differs from other analytic methods because it seeks to describe patterns across qualitative data. On the other hand, Content Analysis is a methodology for determining the content of written, published communications, recorded, objectives, and quantitative procedure. Thus, Thematic Content Analysis is a set of procedures for collecting and organizing data in a standard format that allows analysts to draw inferences about the characteristics and meaning of data. TCA describes the thematic content of focus group discussion transcripts or other

texts by identifying common themes in the texts provided for analysis. TCA is the most essential qualitative analytical procedures and in some way tells all qualitative methods. The research has been grouped and refined from the texts a list of common themes in order to have ample explanation of the common voices across participants. All reasonable data will be categorized in the form of themes from the actual words of participants and to group themes in a manner that directly reflects the texts as a whole. While sorting and naming themes requires some level of explanation, “interpretation” is kept to a minimum. The researcher’s own feelings and thoughts on forming themes or what the TCA themes may signify are largely irrelevant to a TCA. That is, the researcher forestalls the interpretation of the meaning of the identified themes until later in the research report, typically in the Discussion.

In this research, after the transcription of responses from each of the four focus groups yielded data for thematic content analysis, the coding processes was done and arranged into four themes. TCA permit to categorize or to form a theme based on the frequency (number of appearances) and intensity (emotionality) of responses of participants. Given that, content that was coded under the same category led to the development of major themes (Anderson, 2007).

CHAPTER FOUR

DATA ANALAYSIS, RESULTS AND DISCUSSION

4.1. Introduction

This chapter discussed the method of statistical and qualitative analysis of the study. Students', lecturers' and Faculty Head perspectives taken as the main sources of information for this study and were examined against the critical elements, which include the awareness of students and lecturer on the importance of chemistry the perception of lecturer and students towards the process of chemistry learning and to what extent pedagogy based technology is important to enhance chemistry learning. Generally, this study focused on the main themes: the effect of PBT, the perception of students and lecturers, and implication of PBT for electrochemistry learning. The interpretation of the research findings was made in line with the above stated themes.

To investigate the general feature of chemistry learning schedules were prepared for analyses with the help of rating scale having from strongly agree to strongly disagree.

5 = indicates strongly agree

4 = indicates agree

3 = indicates I have no idea

2 = indicates disagree

1 = indicates strongly disagree

$$\text{Average} = \frac{\text{The sum of each scale multiplied by its frequency}}{\text{The total number of respondents}}$$

For example taking question 1 from the student response of the schedule

$$\frac{(1 \times 2) + (2 \times 4) + (4 \times 22) + (5 \times 62)}{90} = 4.530$$

Note that the average shows out of 5

$$\text{Percentage (\%)} = \frac{\text{The sum of respondents who indicate above 3}}{\text{The total number of respondents}} \times 100\%$$

For example for the above question

$$\frac{(22 + 62)}{90} = 93.30\%$$

If the average shows above 3.000 and above it is as indication of agreement with the statement, and mean scores below 3.000 as indication of disagreement.

4.1.1. Effects of pedagogy Based Technology (PBT)

4.1.1.1. The Statistical Analysis

1. Based on the hypotheses this study:

Hypothesis 1: There is no significant difference in students' academic performance in electrochemistry when taught using PBT and when taught using conventional method ($p < 0.05$). $H_o = \mu_1 - \mu_2 = 0$

Where μ_1 = population mean of the control group (the students who have learned by student-centred technique of teaching and μ_2 = population mean of the experimental or treatment group (who have learned by the student-centred integrated with animation, simulation and video = PBT).

With the use of an independent t-test, the following results were obtained.

Table 1: Independent sample t-test's mean and standard deviation of pre test performance

The teaching technique	N	Mean score	SD Deviation
Student-centred method	45	4.67	1.907
Student-centred method integrated with technology (pedagogy based technology method)	45	4.49	1.902

Table 2: Independent sample t-test result of pre test performance (N= 90)

Test	f	t	p	P(2 tailed)
Pre-test	0.006000	0.4430	0.9370	0.6590

According to hypothesis 1, to observe an important effect with this study, there is no significant difference in students' academic mean Electrochemistry performance between the control (those who were taught through student centred technique of learning) and experimental or treatment group (those who were taught through student-centered approach integrated with animation simulation and video) during the pretest at $p = 0.05000$). $H_o = \mu_1 - \mu_2 = 0$.

Electrochemistry performance pre-test analysis for control and experimental group given on Table 2 shows there were no significant differences found between the two groups as p value 0.9370 was greater than 0.05000. The mean pre-test and their

corresponding standard deviation for both control and experimental groups given in Table 1 is (M = 4.670, SD =1.907, N = 45) and (M= 4.490, SD = 1.902, N = 45) respectively. This also confirms their similarity. Besides, the Levene's independent t-test for equality of covariance's for distribution of students both in the treatment and control group ($p > 0.05000$) at $t(88)$ value was 0.4430 and the two tailed p- value was 0.6590 on Table 2 also supports the initial assumption that there was no significant difference between the two groups at the pre-test ($p > 0.05000$). Moreover, the t test showed that there is no a statistically reliable difference between the mean score of experimental group (M = 4.490, SD = 1.902) and control group has (M = 4.670, SD = 1.907), $t(88) = 0.4430$, $p = .6590$, $\alpha = .05000$. Therefore, at $P = 0, 05$ level the null hypothesis is accepted.

Hypothesis 2 There is no significant difference between the mean scores of experimental group and control group in their performance in electrochemistry, ($P < 0.05000$). $H_0: \mu_d = 0$

In the case of paired data, it is a common practice to make use of the fact that the difference between the two population means (i.e., $\mu_1 - \mu_2$) is equal to the population mean of the difference scores, denoted by μ_d .

Table 3 : Paired Samples Correlations of Pre test and Post test for each Group

Teaching method	N	correlation	Sig (p)
Student-centred pre test-post test	45	.2720	.07000
Pedagogy based pre test-post test	45	.1500	.3250

If we assume there is significance correlation ($p < 0.05000$) between the mean pre-test and post test score on Electrochemistry performance of the control and experimental group. But Table 3, suggested that there was no correlation between the pre test and post test performances of students in both control and experimental group with statistical p value of ($p = 0.07000 > 0.05000$) for control and ($p = 0.3250 > 0.05000$) for experimental group.

Table 4: Paired Samples t-test of Pre test and Post test for each Group

Teaching method	Paired Differences			Sig. p(2-tailed)
	SD.		t	
	Mean	Deviation		
Pair 1 Student-centred pre test-post test	-4.844	2.088	-15.561	.000
Pair 2 Pedagogy based pre test-post test	-9.333	2.286	-27.385	.000

Table 5: Paired Samples Statistics

Pair	the mean performance difference of	Mean	N	Std. Deviation	Std. Error Mean
1	control group	4.84	45	2.088	.311
	the mean performance differences of treatment group	9.33	45	2.286	.341

Table 6: Paired Samples Test

		Paired Differences			t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error			
Pair 1	The mean performance difference of control group - the mean performance differences of treatment group	-4.489	2.944	.439	-10.230	44	.000

Table 4 illustrated that, the mean score difference and corresponding standard deviation ($M = -4.844$, $SD = 2.088$, $N = 45$) at t-value 15.561 p-value is 0.000 and ($M = -9.333$, $SD = 2.286$, $N = 45$) at t-value 27.385 the p-value is 0.000 for control and experimental group respectively consequently, there was a significant improvement in the students' performance in both groups.

However, as stated on hypothesis 2 there is no significant difference (at $p = 0.05000$) between the mean score on Electrochemistry performance between the control and experimental group. To check this Table 5 and 6, illustrated that, the mean score difference and corresponding standard deviation ($M = -4.844$, $SD = 2.088$, $N = 45$) and ($M = -9.333$, $SD = 2.286$, $N = 45$) at t-value -10.230 the p-value is 0.000 shows p value $0.0000 < 0.0500$. Since, the p value $0.0000 < 0.05000$ illustrates that the difference between the two mean performances is significant at the 5% level. Thus, null hypothesis is rejected.

Table 7: Homogeneity Slope test between Pre test and Method of Instruction

Levene's Test of Equality of Error Variances^a

Post test	Mean square	F	P
Method of instruction pre test	9.33	.108	0.743

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Group + Pre_test

Prior to running the ANCOVA, the assumption that both experimental group and control group were not related. This was initially tested with homogeneity test. As shown in Table 7, the ANCOVA test for homogeneity, the results for homogeneity slopes confirmed that the interaction between pre test and teaching method was not significantly related (p-value $0.7430 > 0.05000$). In addition as indicated on Table 6, F (87, 1) also shows the there is a significance effect of covariance $p = 0.04800 < 0.05000$ which allows us to proceed to the ANCOVA.

Table 8: ANCOVA test for Post-test (N= 90) Dependent Variable: Post test

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	427.508 ^a	2	213.754	91.839	.000	.679
Intercept	1543.411	1	1543.411	663.123	.000	.884
Group	423.152	1	423.152	181.806	.000	.676
Pre-test	9.331	1	9.331	4.009	.048	.044
Error	202.492	87	2.327			
Total	12880.000	90				
Corrected Total	630.000	89				

a. R Squared = .679 (Adjusted R Squared = .671)

Table 9: Estimated marginal means from ANCOVA (N = 90)

group or teaching technique	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
control group	9.496 ^a	.228	9.044	9.948
experimental group	13.837 ^a	.228	13.385	14.290

a. Covariates appearing in the model are evaluated at the following values: pre test of the target group = 4.58.

When examining whether there was evidence for greater improvement in the experimental group than the control group on the mean post test of Electrochemistry performance, comparing the mean score between the two groups after controlling the pre test, it was evident that learning the abstract and complex topics of Electrochemistry with PBT shows significant improvement or gains over the control group as shown in Table 8. The significant p-value ($0.000 < 0.05000$) explains that the PBT (animation, simulation and video integrated with student-centered technique of learning) has a greater effect on visualizing the abstract and complex topics of Electrochemistry i.e. “PBT” is a significant predictor of scores on the “Electrochemistry students’ performance”.

The effect size index rating (i.e. 0 = no effect up to 1(greater effect) the eta-squared value in Table 8 and estimate marginal means in Table 9 also substantiate that the teaching method ($\eta^2 = 0.6760$) had much greater effect on a post test than pre-test ($\eta^2 = 0.2280$) in which 13.83 is much larger than 9.496 shows that PBT has greater effect on the students performance than usual technique of teaching. According to Cohen eta-squared value (0.01000 very small, 0.06000 medium, and 0.1400 and above is greater (Cohen, 1988).

As shown in (appendices C and D), where the participants were asked whether “Students are interested to learn chemistry” or not. 82 (91.1%) students indicated that they were interested to learn chemistry. 9 (75%) of the sampled lecturers who taught the students also agreed with the students with such comments like:

- Chemistry has a horizontal relation with various subjects such as mathematics, physics, biology and medicine which enable them to examine various phases of the nature;
- Chemistry is the core for development in the areas of industry, agriculture, health and technology;
- Chemistry is a subject which enables one to know various properties of matter;
- Learning chemistry enables us to know the purification of many things;
- Chemistry is an experimental science which enables us to discover new things;
- Students are eager to know the secret of nature;
- Learning chemistry is linked with day-to-day life.

However, 8 (8.9%) of the sampled students and 3 (25%) of the sampled lecturers suggested that students were not interested in studying Chemistry because chemistry is assumed to be difficult by most students due to the reason that:

- Lack of appropriate background from their earlier schools;
- Complexity of the subject;
- Some students joined the department without interest.

This indicates that even though students have interest to learn chemistry. Owing to the complexity of the chemistry subject they have no understanding as a result they were not willing to join the department.

As reported in question 2, appendices F and G and the result in appendices C and D, 51(56.6%) of the sampled students and 8(66.7%) lecturers have no conviction that student-centred technique of teaching is effective to teach all topics of chemistry, but 37(41.1%) sampled students and 4(33.3%) sampled lecturers believed in the efficacy of the student-centred technique of teaching. However, 2(2.3%) of the sampled students were on the fence and indicated no idea.

Considering the results for question 3, appendices F And G and the result in appendices C and D, which said “Chemistry students do not score very well if they learn chemistry by traditional method of teaching.”, 67(52.1%) of sampled students. On average 3.8, and 8(67%) sampled lecturers on average 3.7 agreed with the statement. Nevertheless, 18(20%) of participant students and 4(33.3%) lecturers agreed with the concept of the statement excluding 5(5.5%) of the students who had no idea.

Consequently, when the sample students and lecturers were asked about statement 4, “The participation of the students is not very good with traditional way of teaching”, 71 (78.9%) of the students on average 4 and 9(75%) of the sampled lecturers on average 3.8, suggested that there is no encouraging level of participation of students when this approach is used. On the contrary, only 16(17.7%) of the students and 3(25%) lecturers that taught them said there was a good level of student participation.

The following reasons were suggested from the participants for limited participation of students.

- ⇒ It is teacher dominated giving no chance for students to participate;
- ⇒ It is based on the will of the teacher, if he is interested he may ask a few questions to some clever students;
- ⇒ There is no equal opportunity for the students;

- ⇒ The teachers are always in a hurry to cover bulky portions of the lesson;
- ⇒ The delivery is dependent on the teachers' concept knowledge, so the students have no further ideas on how to participate.
- ⇒ Little or no opportunity which invites students to participate in the lessons.

The few respondents in favor of the teaching approach reasoned that:

- ⇒ "Lecture" is a good technique to acquire clear concepts because the teachers are better than students.
- ⇒ When there is time, the teachers may give chance to their students to participate.

This proves that only, few respondents support the traditional and student centered technique of learning. As indicated with most respondents it is evident that both techniques give no opportunity for students to understand all concepts of chemistry.

4.1.1. 2. The perception of students and lecturers towards PBT

For question 5, which asks whether Debre Berhan University has experience of using animation, simulation and video, 66 (73.3%) of the sampled students on average 3.7 and 9(75%) sampled lecturers on average 4, responded that there was no practice of such things, while 20 (22.2%) of the students and 11(8.3%) lecturer presumed there was a skeletal experience of using animation, simulation and video while 4(4.5%) students and 2(16.7%) lecturers said they had no idea.

The use of animation simulation and video was not widely applied in supporting chemistry education however; research reports from many countries have demonstrated a positive impact of animations and simulation on understanding unobservable processes as a technique of visualization (Kozma & Russel, 2005). In a similar manner, the

suggestion obtained from Debre Berhan university sampled students and lecturers confirmed that lectures have no such practice in teaching chemistry.

For statement 6, which asks “the students can acquire clear understanding of concepts if they learn chemistry lessons supported by simulation, animation and video”, majority of sample students 84(93.3%) on average 4.5 and all lecturers 12(100%) on average 4.8 agreed that animation, simulation and video technologies are very good to support students to acquire clear understanding of concepts. However; 4(4.4%) sample students opposed the idea.

Furthermore, for statement 7, “learning supported with simulation, animation and video enable students to recall main points easily.” As shown on (Appendix I), 85(94.4%) of the sampled students on average 4.54 and all 12(100%) lecturers on average 4.8 agreed with the statement. Nevertheless, 5(5.6%) sampled students opposed the statement. According to most of the sampled students and lecturers, the reasons offered for animation, simulation and video enabling acquisition of clear comprehension of concepts and enabling students to recall were that:

- ❖ The students can easily observe things;
- ❖ They do the operation by themselves, so they can understand it better and faster;
- ❖ When they hesitate they can retrieve it again;
- ❖ When they have a time to discuss among themselves, they interact, think deeply and take the most information/idea;
- ❖ The visualizing aid clearly shows the theory involved;
- ❖ Observing enables the student to retain and remember what has been taught;
- ❖ It makes things easy and simple;

- ❖ Learning through animation, simulation and video attracts attention and creates images in the students' mind; hence it enables acquisition and recall of concepts;
- ❖ It enables the students to relate their ideas with their surrounding realities and

Other than this, there were astonishing sayings heard from two individuals.

One student from the experimental group said, "*In the middle of our class I was very happy and thinking what would happen in the future with such type of technology.*"

In a similar manner, one lecturer from the focused group said "I appreciate it, I think there is a lot expected from us the university lecturers and teachers and there are a lot of things which will be discovered in the near future."

The finding both from the mentioned reason and the suggestion from the two respondents showed that the application of animation, simulation and video was essential to make the abstract and complex concepts clear and to create enjoyable learning environment.

As indicated in Appendices F And G and the result in appendices C and D, on "Learning the abstract or complex lesson of chemistry through simulation and animation integrated with student-centred method is clear and understandable.", 82 (91.1%) of the sample students on average 4.4 and all 12(100%) sample lecturer on average 4.8 accepted and agreed with the statement. But 6(6.7%) students disagreed with the idea in the statement while 2(2.2%) students indicated no idea.

The reasons advanced by those who supported the idea were that:

Animation, simulation and video enable us to see abstract and complex particles which are impossible to see by other means.

They make concepts easily understandable, such as ion, electrons, the motion of electrons and the chemical phenomena happened at the electrode (Appendix J).

- ◆ Animation, simulation and video enable us to observe abstract and complex matters: they open discussions among group members, enabling us to analyze issues and this leads to better idea about concepts;
- ◆ Animation, simulation and video enable us to see the reactions, motions and formations associated with abstract and complex matters;
- ◆ Animation, simulation and video once they are loaded on the computer, it enables students to retrieve information when they need to examine it in detail;
- ◆ Animation, simulation and video fill the gap that is there in the student-centred learning and becomes more effective when they implemented together;
- ◆ It is new and attracts attention, makes the student interested to attend the lessons;
- ◆ It uses most of the senses of the students;

In a similar way, the result obtained from respondents showed that the application of animation, simulation and video is very important to make the abstract and complex concepts clear and to create enjoyable learning environment.

In response to statement 9, “virtually seeing the abstract or complex lesson enables the student to remember the main points.” (Appendix I), 82(91.1%) sampled students on average 4.4 and 11(91.6%) lecturers on average 4.6 believed and agreed with the statement. Nevertheless, 6(6.7%) of the students and 1(8.4%) lecturer disagreed with the idea, and 2(2.2%) students showed no response of any type.

In support of the above, almost all the participant students and lecturers opined that virtually seeing the abstract or complex lessons helps in:

- ⊗ Creating images in students' minds.
- ⊗ Showing the features of things (though it is not real), enlarging the abstract, exposing the complex, bringing the far to the nearest and by creating the real image in students minds it enables the students to remember the main points.
- ⊗ Making minute things observable, which is not possible by other means in the class room setting.
- ⊗ Showing the dynamic nature of particles, such as the movement of electrons, atoms ions and molecules in a similar manner to the real.
- ⊗ Showing the facts.
- ⊗ Capturing the attention of students, it makes them interested, invites them to examine the physical and chemical properties of particles, conceive the true concepts and makes learning simple, easy and enjoyable.
- ⊗ Showing different features together such as picture, motion and sound.
- ⊗ Seeing things that make recalling the concepts easily.
- ⊗ When students observe the virtual particles they try to relate what they have observed to their day-to-day activities and the surrounding real world which enables them to remember easily the concept.
- ⊗ Showing things which are difficult to understand, theoretically.

As mentioned above it is possible to conclude that the use of animation, simulation and video allows observing abstract and complex concepts of chemistry which enable learning unforgettable.

Only 2(2.3%) sample students disagreed with the statement 10, which says that "Learning through animation, simulation or video reduces the abstract nature of the

lesson.” But 88(97.3%) sampled students on average 4.36 and all 12(100%) lecturers on average 4.8 believed and agreed with the statement.

On statement 11, which says, “Learning through animation, simulation or video reduces the complexity of the lesson”, 1(1.2%) of the sampled students was not in agreement with the idea while 89 (98.9%) of the students on average 4.58 and all 12(100%) lecturers on average 4.8 were in favor of it.

Their justifications for supporting the statement were that:

- 📖 These instruments have the power of making unobservable things to be observed and contribute for understanding clear concepts
- 📖 They make the abstract and complex concepts clearer and open the way for interaction which enables us to acquire and comprehend concepts better.
- 📖 These technologies make the ideal things observable.
- 📖 They make learning interesting.
- 📖 These technologies reduce and sometimes remove confusion in learning.
- 📖 Visualizing creates images in our mind, makes us to remember things faster.
- 📖 PBT makes learning enjoyable and interesting.
- 📖 Using these technologies enables us to see things in three dimensions.
- 📖 They attract the attention of students, making learning enjoyable and enable them to focus on their learning.

Statement 12 says that “Virtually seeing the motion, interaction of particles and changes of state contributes for easiness of the lesson.” 80(88.9%) sampled students on average 4.23 and 6(50%) lecturers on average 3.3 supported the statement while 8(8.8%)

students and 2(16.6%) lecturers opposed the idea. 2(2.3%) of the students and 4(33.3%) lecturers indicated no idea.

When sample students were asked to comment on statement 13 that says “Most of students did not relate the chemistry lessons with their personal goals.”, only 22(24.4%) of the students on average 2.26 and 7(59%) lecturers on average 3.7 agreed to the statement. 59(65.6%) students and 3(25%) lectures disagreed with the statement, while 9(10%) students and 2(16.7%) lecturers had no responses.

In response to statement 14, “Most of the students did not relate the lesson they have learnt to the real world.” 26(28.8%) students on average 2.26 and 6(50%) lecturers on average 3.8 agreed to the statement. Yet, 62(68.9%) sampled students and 3(25%) lecturers did not favor the statement, while 2(2.3%) students and 3(25%) lectures had no responses.

An overwhelming majority of sample students 82(91.1%) on average 4.42 and all lecturers 12(100%) said that statement 15, which says “Learning through simulation, animation and video can increases the interests of students to learn chemistry” was true. However, 5(5.57%) students opposed the idea and 3(3.33%) other students had no idea.

To respond to statement 16, that, “Learning with PBT (i.e. animation, simulation and video integrated with student-centred approach) increases the quality of learning chemistry.”, 81(90%) of the students on average 3.8 and all 12(100%) lecturers on average 4.8 believed and agreed with the statement. 6(6.67%) of the students opposed statement and 3(3.33%) other students had no idea.

The respondents` justifications for favoring the statement were that:

⇒ Almost half of the chemistry lessons are abstract and complex.

- ⇒ It enhances the interest of students.
- ⇒ It has a power to change the perception of students and to assume chemistry is easy and simple.
- ⇒ PBT makes learning simple and understandable
- ⇒ PBT makes the abstract and complex things observable and understandable.
- ⇒ Increases the power of students to see things from different angles.
- ⇒ Makes students to learn by themselves.
- ⇒ Opens more means and opportunities for interaction among students.
- ⇒ Provides information.
- ⇒ Increases skills learning ability by combining many things and senses.

Answering question 6 “What is the importance of Technology?” Presented in the focused group discussion most of the groups’ participants suggested that it is very important motivating students’ interest; it prepares the student to become more scientifically literate citizens; it has the power to make the abstract and complex things observable and understandable. They further stated that it can open a means for interaction among students by making invisible visible, the complex clearer and the far to become nearer and it can give some measure of responsibility to students’.

Only 3(3.33%) sample students opposed statement 17, which asks, “The chemistry I learn will be helpful in my day-to-day activities with various aspects in my life.” while 87(96.7%) of the students (agreed to it. On statement 18 “The chemistry I learn is more important to me than the grade I receive.”, only 5(5.6%) of the students opposed the statement whereas 85(94.4%) sample students on average 4.7 agreed with the idea.

Only 1(1.1%) of the students opposed the idea in statement 19, which says that “being a chemistry student understanding the chemistry courses gives me a sense of accomplishment.” 88(97.8%) students accepted and agreed with the statement and 1(1.1%) other student had no idea.

Generally, it is apparent that students know clearly the significance chemistry for their life and their country but they hate it due to its unclear concepts. However, it is possible to solve this using pedagogy based technology (animation simulation and video) integrated with appropriate learning technique such as student centered leaning. That can open a means for interaction among students by making invisible visible, the complex clear and the far near and give responsibility to students.

4.1.1.3. The Perception of Students, Lecturers’ and College head towards the Implementation of Pedagogy based Technology

It is obvious that most of the time, lecturers tell their students about the importance of chemistry at the beginning of their classes.

For the question 28, posed to know the perception of chemistry students and lecturer by asking, what do you think chemistry is about?

88(97.8%) students and 11 (91.6%) sampled lecturers suggested similar answers like:

- ↻ Chemistry is a science which enables us to examine, and reshape matter and through this improve the standard of living of man and his surroundings; thus it is the heart of science.
- ↻ Chemistry is the core of development because it is very important in areas of agriculture, medicine, industry and technology.

↻ Chemistry is a subject which enables us to know the physical and chemical properties of matter including man and his surroundings.

Parallel to this for question 1 raised in the focus group discussion, which asks “What are the importances of chemistry”, the participants in all four focus groups discussed and finally reached in agreements with the following:

↻ Chemistry is very important in order to determine the composition, properties and structure of matter.

↻ Chemistry is the core for industrial process to produce, agricultural supplies, medicine, instruments and equipment, foods and for the development of technology.

↻ Chemistry is very important in order to understand our surroundings and ourselves.

As the students and lecturers responded to the question, “you have seen that both the traditional and student-centred way of teaching were not able to remove ambiguity of some lesson for many students. What do you think could be the reasons?”

The sample student’s responded that it was because of lack of:-

- Supporting materials.
- Visualizing materials.
- Student commitment.
- Clear understanding of the chemistry lessons
- Awareness about the chemistry.

The lecturer responded it was due to:-

- The style of teaching used by the teachers.

- The abstract nature of chemistry lessons
- Lack of experience about students' background.
- Lack of supporting visual aids.
- Absence of a well organized laboratory which attracts the students' interest.

According to these findings ambiguity of some lessons in chemistry for many students was not solved by the traditional and student-centred way of teaching.

There are situations which make human beings happy and those which make them depressed; when sample students and lecturers were asked about their state of happiness and depression during learning or teaching of chemistry, the students responded that they were happy learning chemistry. This was by relating their day-to-day activities and their surroundings, when they learn chemistry well and score good mark, when their interest is fulfilled and when they apply their knowledge to do things. The lecturers similarly responded that they have full joy and happiness when they observe students with good attention and interest and when they see bright face on their students during their teaching. The corresponding question 2 raise in the focus group discussion was, "What kinds of topics are more interesting to you?" Similarly, from all four groups, suggested that when students participated interestingly and happily.

On the other hand, students felt depressed when they saw chemistry as vague and difficult, when they found the lesson misty and not clear, when the teacher focuses on lecturing, when they forget chemistry concepts in the exam and when they "know nothing". Lecturers in the same manner replied that they get depressed when there is no access to the supporting materials that make teaching better, when they see careless and aimless students.

For question which said “what seems to be the application of visualizing technology in Debre Berhan University?” All lecturers and students replied poor, which expressed that there were no practices of using visualizing software of animation, simulation or video to teach and learn chemistry.

4.1.2. Implication

For question which asks “What are the challenges to apply these technologies?” All 12 lecturers and 89 sampled students responded that it was due to lack of computers, software and lack of experienced lecturers, however; they suggested that it is better if the lecturers try to support their teaching with visualizing materials which create a good awareness about chemistry subjects. This informs us that the students possibly acquire clear concepts when they learn abstract and complex concepts of chemistry supported with animation, simulation and video according to their significances. From the implication above it is clear, if the student-centered learning is supported with visualizing materials as in case of PBT it would have a power to make learning clearer and opens the means for interaction between students as well as with the teacher. It is better if there is co-operation among students, lecturers and the university management to make chemistry learning easy and to increase the quality of education.

4.2. Discussion

The discussion section provides arguments that the researcher explored and attempted to explain findings that were obtained from the study. Within this section, the researcher tried to interpret findings and relate these to both the purpose of the study and to the reviewed results from other studies examined in the literature review. This section

may be used to forward theories or raise questions regarding previously developed theories.

This study embarked to evaluate the effectiveness of the PBT in meeting the aims of learning chemistry. For the purpose of this some of Electrochemistry's abstract and complex concepts were explored.

4.2.1. The difficult nature of chemistry

The purpose of this study was to identify if there is any difference in student performance when complex and abstract chemistry topics were taught using the student-centred technique of teaching integrated with animation, simulation and video PBT compared to the usual student-centred method used in chemistry learning at the Debre Berhan University in Ethiopia.

When the students were asked about the importance of chemistry, they gave astonishing explanations and showed how interested they were to learn chemistry. But many of the students scored low in chemistry, which indicated that there was a problem in understanding the concepts of chemistry with the traditional method as well as the student-centred way of learning in the university. Constructivist theory stated that students can learn better when they are constructing their own meaning based on their experience (Cobb & Yackel, 1996; Davis, 1993; John and Staver, 2007; Kanselaar, 2002; Silbeman, 1996) most of the chemistry concepts are abstract and complex. Thus, is it possible for students to envisage these things in their mind clearly? So, what are the reasons for most of the students assumed that chemistry is difficult subject to an extent they choose not to join chemistry department (McCormick & Li, 2006; Robinson, 2003; Sellers, et al, 2007)?

This implies that there were unclear concepts in chemistry which inhibit students to join this stream. As reported by many research reports, concepts and phenomena in chemistry are abstract and complex and can only be understood and communicated through the use of chemical representations (Hilton et al., 2010). Conversely, the understandings of these chemical processes such as electron transfers, ion conduction, inter molecular and intra molecular bonding as well as dynamic chemical phenomena is fundamental to learn chemistry at the university. However, as we have seen from the above explanation, students find it difficult to visualize these abstract and complex concepts; on the other hand, it is evident that any misconceptions and alternative conceptions that students have about these microscopic particles will impede further learning of chemistry (Gupta-Bhowon et al., 2009; Simsek, 2009). It is equally true that one of the most difficult challenges in learning chemistry at the university level involves the complicatedness and the dynamic interactions of atoms, molecules and ions (Coll & Treagust, 2001a; Coll & Treagust, 2003; Garnett & Treagust, 1992a, 1992b; Harrison & Treagust, 1996; Sanger & Greenbowe, 1999; Zoller, 1990). Students have difficulties in visualizing these atoms, molecules and ions in three dimensions and many of them are not able to understand various chemical phenomena (Tsaparlis, 2003; Mahaffy, 2005). Based on this, this research tried to fill the gap using visualizing software such as animation, simulation and video. Animations and simulations visually help students to understand difficult concepts related to the dynamics of complex chemical systems. Animated and simulated visualizations that show both structures and processes help teachers convey important scientific concepts in chemistry. Specifically, animation,

simulation and video developers seek to design visualizations that allow students to learn abstract and complex concepts and relationships between these concepts.

4.2.2. Effects of pedagogy based technology

As expected, the students in the experimental group who were taught by technology of animation, simulation and video scored significantly higher on the post-test compared to the control group who received their lessons just by the usual student-centred learning method. The pre-test and post-test measured the performance level of both the experimental (treatment) and control group. The finding depicted that student-centered learning integrated with visualizing software such as animation, simulation and video showed better results in the post-test in the experimental group than the control group. This revealed that the use of PBT has a greater effect on the performance of chemistry students. It is motivating to observe that even after they have finished the treatments students were trying to find similar visualizing materials on their own. The results also showed that most students in the experimental group were happy and dropped their assumption that chemistry is a difficult subject. The extent to which this happened varied, of course, among the individual students. Although the sampling technique, being convenient sampling, may have caused sampling errors, the statistical analysis of covariance (ANCOVA) eliminated all possible contamination errors, sampling errors and other extraneous variable. Hence the result illustrated that there is a big difference between PBT treated students and control group members. Of the questions in the post tests, from 13 multiple-choice questions prepared in Electrochemistry the majority of the treatment group students had 9-12 correct answers (Appendix E).

Taking a closer look at the answers to open-ended questions, it was seen that there was an overall similarity amongst the treatment students to give correct answers. More accurate answers were seen in the focused group discussion; their answers were more precise, reasonable and their reasons were supported by examples. Generally, the focused group discussion answers of the treatment group were more accurate than the control group, they were used concepts like the motion of ions and the motion of electrons and their retention rate was increased. On the basis of this finding, it is possible to assert that students scored higher in the performance tests after completion of the “treatment”. This was evidenced by the fact that even after eight weeks (two weeks for training and six weeks (18 periods) of the research programme), students were searching for many web sites to find similar solutions for other complex and vague concepts eager to see more of such type of clear lesson.

Furthermore, the result of the performance measure has shown that there is a statistically significant difference between student-centered and PBT in terms of students performance in chemistry. From this it is possible to say computer-assisted-learning (computer animation, simulation and video) has a greater effect on learning the abstract and complex concepts of chemistry. Since PBT as mentioned by the sample students and lecturers in the open schedule question, and the opinion obtained after argument in the focused group discussion enables students to see the intended invisible things which cannot be seen by other means; increases students` interest and motivates the students to learn; enhances the student`s understanding of the abstract and complex chemistry concepts; it combines the motion, the sound and picture of particles which enables students to use all of their senses. (Elliton et al, 2005; Kargiban & Siraj, 2009;

Mahaffy, 2005; Mujibul, 2004; O'Neil, Ray & Perez, 2003; So & Kim, 2009; UNESCO, 2005).

The findings from this study were consistent with the work of Falvo (2008) who investigated about molecular learning and National Academy (2011) about the use of simulated visualization. In both cases animation and simulations were used to make clear the intangible molecular processes (Falvo, 2008) and simulation was used to visualize and enhance students' understanding showing that simulations have great potential to improve science learning in undergraduate science topics. It can individualize group learning to match the pace, interests, and capabilities of each student or group and contextualize learning by participating in virtual environments. If the universities serve all students, the increased use of simulations in science classrooms could potentially improve access to high-quality learning experiences (National Academy, 2011).

Animations, simulations and video are external representations of phenomena of particles, which correspond to the mental images that chemists use to solve the invisibility problems. When students connect their macroscopic observations of the phenomenon to the virtual representations they will really learn chemistry and truthfully see chemical processes (Falvo, 2008; National Academy, 2011). This study mainly focused on the abstract and complex topics of chemistry as well as the combined effect of integrating this visualizing software with student-centred techniques of learning.

Many sampled students and lecturers suggested, the continued use of animation; simulation and video software through integration with appropriate pedagogy for abstract and complex topics. This indicated that the use of animation, simulation and

video integrated with appropriate student-centred techniques of learning have capacity to solve the abstract nature and complexity of chemistry learning at Debre Berhan University.

4.2.3. Implication

The use of animation, simulation and video software in classroom learning can have several implications for students' academic performance. Students can gain better conceptual understanding of the abstract and complex concepts of chemistry through the interaction of this visualizing software. Learning through animation, simulation and video increases interest and motivation to learn, it also makes the abstract and complex chemistry concepts observable, simple and understandable. It increases the power of students' thinking from different angles and makes students ready to know the real world. It encourages students to learn by themselves, opens a means for interaction, argument and engagement among students. In addition it can provide information and increases the skill of learning by combining all senses. Thus, from this research finding it is possible to say that animation, simulation and video enable us to provide quality education and to build a higher level of thinking which fills the gap in student-centred learning.

4.3. Chapter Conclusion

The results of Electrochemistry post test indicated that students who were taught by animation, simulation and video integrated with a student-centered approach, were more successful than the students who were taught by usual student-centred technique of teaching. Students' interest and attention can easily be attracted with the application of

animation and simulation on the computer. In addition, knowledge acquired is not easily forgotten, because they can hear sounds, see animation, simulation and videos and operate the computer according with their pace, the number of sense organs used increased in the learning process. It can be concluded, that technology/computer-assisted learning is more effective than the usual student-centred learning method on students' perception towards Electrochemistry (Elliton et al, 2005; Kargiban & Siraj, 2009).

Thus, PBT is the most promising and attractive way of learning complex and abstract concepts of chemistry. The students in the experimental group accepted and valued science learning as being something interesting which enabled them to see many hidden secrets of their learning. Their opposition has been changed. They recognized that this type of approach is different as it makes them busy and absorbed in their learning to know many things in a real sense. This change within the affective and cognitive dimensions suggested that the students need changes which cause them to learn and progress. On the other hand, the lecturers that participated in the schedule and focus group discussions were interested about its implementation.

This shows that animation, simulation and video integrated with student centered learning have great potential to improve chemistry learning in undergraduate chemistry classrooms. It can individualize learning to match the pace, interests, and capabilities of each student or groups and contextualize learning to engage in virtual environments, it increases interest and motivation to learn, makes the abstract and complex chemistry concepts visible, simple and understandable, increases the power of students observation from different angles, it makes the students ready to know the real world, encourages the students to learn by themselves, opens a means for interaction, debate and engagement

among students, provides sufficient information and increases the skill of learning by combining all senses. Increased use of animation, simulations and video particularly for vague and difficult chemistry concepts could potentially improve access to high-quality learning for all.

Furthermore, animations, simulations and video visually helped students to understand difficult concepts related to the dynamics of abstract and complex chemical phenomena. Animated and simulated visualizations that show both structures and processes also helped lecturers to convey important scientific concepts in chemistry. Specifically, animation, simulation and video developers seek to design visualizations that allow students to learn abstract and complex concepts and relationships between these concepts (Falvo, 2008; National Academy, 2011).

The significance of simulation in providing clear concept and its contribution to have high quality learning system were well supported with many literatures (Elliton, *et al*, 2005; Kargiban & Siraj, 2009; Mahaffy, 2005; Mohanty, 2007; O'Neil, Ray & Perez, 2003; Mujibul, 2004; So & Kim, 2009). However, further research is essential in ascertaining the instructional benefits of educational simulations, animation and video as modalities for situated learning.

CHAPTER FIVE

SUMMARY, LIMITATION, CONCLUSION AND RECOMMENDATION

5.1. Summary

The purpose of this study was to determine any difference in students' performance when the complex and abstract chemistry concepts were taught using the student-centered technique of teaching integrated with animation, simulation and video (Pedagogy-Based-Technology) compared to the usual student-centred method in chemistry learning at the Debre Berhan University in Ethiopia. As shown in chapter one, many students had difficulty in learning chemistry and according to different research reports, the difficulties arose from the abstract nature and complexity of chemistry topics. To see the effect of Pedagogy-Based-Technology in chemistry classrooms, the sequential embedded mixed research (quasi experimental and explanatory) case study design which consisted of a schedule survey as well as a qualitative open ended and focused group discussion methods of data gathering were employed.

There are two ways of delivery of education in Ethiopia the traditional and the constructivist (student-centred) ways. The review part showed that there is a gap in both the traditional and constructivist ways of learning to disseminate clearly the abstract and complex concepts of chemistry (McCormick & Li, 2006; Robinson, 2003; Sellers, et-al, 2007). On the other hand, there are visualizing software such as animation, simulation

and video (Mahaffy, 2005; So and Kim, 2009) that could be used to close up the observed gaps.

The main findings of this research include the following:

- ☞ Students who took all part of their class lessons by PBT performed better on the average, than those who took the same course through student-centred technique of learning.
- ☞ Instructions combining the use of animation simulation and video with student-centred learning had higher advantages than purely student-centred technique of teaching.
- ☞ Students in the Pedagogy-Based-Technology learning approach class are more interested than students in the student-centred approach and experienced a greater benefit from animated, simulated and video supported learning.

The effectiveness of Pedagogy-Based-Technology learning approaches appeared quite broad across different content and student types. This was because: It involved engaging virtual environments, individualized learning to match the pace, interests, and capabilities of each student or groups. It also contextualized learning, raised motivation to learn, and made the abstract and complex concepts observable, simple and understandable. Increased the power of students to examine things from different angles, it make students ready to know the real world and encouraged students to learn by themselves. In the same way, it opened a means for interaction, made students participant, provided sufficient information and increased the skill of learning by combining most of the sense. Universities are expected to serve all students and

relatively increased use of animation simulations and video in chemistry classrooms could potentially improve access to high-quality learning experiences.

- ☞ Effect size was larger for the performance of students through Pedagogy-Based-Technology approach that shows Pedagogy-Based-Technology approach was better than student-centred approach.
- ☞ The result of the electrochemistry post-test indicated that students, who were taught by animation integrated with student-centred approach, were more successful than the students who were taught by pure student-centred approach.
- ☞ It can be concluded that computer assisted learning was more effective than student-centred on students' perception towards chemistry. Thus, Pedagogy-Based-Technology is the most promising and attractive way of learning for complex and abstract lesson of chemistry. The students in the experimental group accepted and appreciated science learning as being something interesting which allowed them to see many hidden secrets.
- ☞ From this research finding Table 6-9, elements such as animation, simulation and video or PBT greatly influenced the process of learning that students experienced in PBT classes (Falvo, 2008; National Academy, 2011).

Student-centred learning can be enhanced by making students have control of their interactions with visualizing software and thereby prompting student learning power. Providing guidance for learning groups of students with the usual student centered methods appeared less successful than using such mechanisms even with individual students.

5.2. Limitations of the study

The quasi-experimental and explanatory case study design chosen for this study presented differing limitations. Qualitative methods were addressed in a particular fashion to eliminate threats to credibility and validity. Both methodologies were used in this study to complement the findings of the other and provide triangulated data necessary to aid in checking the validity of the quasi-experiment findings (Gall, Borg, & Gall, 1996).

The chosen sampling strategy presented limitations through the focused sampling from a single research-intensive university located in a particular geographical region and from specific academic institution within that setting. This limited the application for other higher institution or transferability of results. It also limits implication to other tertiary-level institutions or faculty members to other colleges or departments in other geographical settings. For the reason that, the focused group discussion method used has supplied rich descriptive, explanatory information as the segment of the qualitative component of this study had its own strength when it is applied in small sample; however, it limits the transferability of the study to other contexts since it is not representative for other contexts (Patton, 2002).

The data presented were from an individual university therefore, should be regarded as illustrative rather than exhaustive.

5.3. Conclusion

Many students have difficulty of learning abstract and complex concepts of chemistry. According to many researchers reports, most of the time these difficulties arose from the invisibility of particles in chemical phenomena.

The finding of this research showed that the students who were taught by Pedagogy-Based-Technology approach performed better than those who were taught by the usual student-centred approach. This shows that animation, simulation and video integrated with student-centred techniques of learning played a great role towards visualizing of the abstract and complex concepts of chemistry. This was because PBT enabled to see the abstract and complex concepts of chemistry; besides this, it had captured the attention of students, made them interested, motivated and absorbed them in chemistry learning. Since it involved picture, motion and sound, it engaged most of the senses and affected students' cognitive, affective and psychomotor domains of learning. Animation, simulation and video integrated with student-centered technique of learning had the potential to fill the gap in student-centred technique of learning and it is effective to learn abstract and complex topics of chemistry. It assisted students to achieve better performance, greater success and long lasting memories.

The advantages the use of technologies by lecturers appeared to be obvious: to increase students' interest in learning, to retain the subject matter, and to have the ability to illustrate concepts in a number of ways. The ready presentation of compact disk is available to the students outside the classroom, via computer or video (Su, 2008). The combination and presentation of characters, graphs, animations and sound effects,

attracted students' eye-sight, motivated for learning, and made better and effective learning.

5.4. Recommendations

Science in general and chemistry in particular, has a great contribution to change and improve life in different fields. However, due to the abstract nature and complexity of concepts of chemistry, the number of students joining to this stream is declining. on the other hand, software such as animation, simulation and video have the capability to visualize the abstract and complex concepts and were found effective when integrated with student-centred way of learning.

In the light of this, the following recommendations have been forwarded:

1. One key recommendation of this study is that chemistry teaching should aim at providing the students with quality learning by supporting with suitable learning environment, such as the use of animation simulation and video integrated with student centered technique of learning. This is because suitable learning environment improves their ability to create new meaning since the facts obtained from these environment help to reorganize and acquire the true knowledge
2. Learning chemistry must focus on the opportunity that gives the students to engage in activities and use their experience, by supporting with appropriate learning environment to construct their own meaning specifically Animation, simulation and video integrated with student centered technique of teaching. Evidences from this study have also shown that learning activities that engage the students in creating their own meaning were student-centered techniques of

learning. Supporting this, the lecturer and students proposed that animation; simulation and video can make the abstract and complex concepts observable; increase interests and performance of students. Therefore, the application and the utilization of appropriate PBT are recommended to ensure students effective participation and learning of chemistry.

3. It is further recommended that lecturers use the animation, simulation and video software by integrating with appropriate student-centred techniques of learning to motivate, enhance learning abilities and to increase curiosity of students in learning abstract and complex concepts of chemistry. Therefore, it should be the lecturer's commitment and efforts to use animation, simulation and video software whenever necessary.
4. The university management and administrators should be convinced and aware of the importance of these visualizing software in the student-centred learning and prepare conducive chemistry learning environment by providing:
 - i. equipped computer room or laboratory to be used by chemistry lecturers and students; and
 - ii. appropriate software and databases.

5.5. Suggestion for Further Studies

An extended study by way of replication of this study with higher samples may help to understand the multi dimensional benefit of computer assisted learning (computer animation, simulation and video integrated with student-centred learning) or Pedagogy-Based- Technology. Thus, a possible extension to this study should cover a variety of universities and may aim at evaluating the effectiveness of animation,

simulation and video to supplement student-centred ways of learning because students need to work at their own pace.

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APPENDICES

Appendix A:

The Informed Consent

UNIVERSITY SOUTH AFRICA (UNISA)

INFORMED CONSENT FORM

The following information is being presented to help you decide whether or not you want to be a part of a minimal risk research study. Please read carefully. If you do not understand anything, please contact the principal researcher, Hailegebreal T.D. (Tesfaye Demissie Hailegebreal), e-mail tesfayedh07@yahoo.com

Title of Study:

Effects of Pedagogy-Based-Technology on Chemistry Student's Performance in Higher Institutes of Ethiopia: A Case of Debreberhan University

Principal Investigator:

Tesfaye Demissie

Study Location(s):

Debere Berhan University Ethiopia

Objectives

1. To investigate the effects of pedagogy-based- technology on student's performance with chemistry lessons such as electrochemistry for second year chemistry students.
2. To assess the opinion of chemistry teachers and students about the implementation of student centered approach integrated with animation, simulation and video to teach chemistry at Debre Berhan University.
3. To suggest possible ways forward in chemistry teaching in Debre Berhan University

Plan of Study-Procedures:

Participation in this semester study will require approximately 13 hrs of your time over the semester. Your involvement in the process will require you to do the following:

- Participate in learning electrochemistry in the treatment or control group answering schedule and participate in focused group discussion.

Benefits of Being a Part of this Research Study

- The direct benefits of your participation in this study will help us to suggest effective teaching learning process.

Risks of Being a Part of this Research Study

- No significant risks or discomforts are associated with your participation in this study. If you agree to participate in the assessments, Schedule and focused group discussion(s) you will be part of either treatment or control group of learning electrochemistry and taking a pre and post test.

Confidentiality of Your Records

Any information obtained during this study which could identify you will be kept strictly confidential. Your privacy and research records will be kept confidential to the extent of the law. However, certain people may need to see your study records. By law anyone who looks at your records must be keep them confidential. The only people who will be allowed to see these records are the study supervisors who make sure that we are doing the study in the right way. They also make sure that we protect your rights and safety:



The data will be stored in a locked cabinet in the investigator's office and will only be seen by the investigator during the study and for two years after the study is complete. The information obtained in this study may be published in scientific journals or presented at scientific meetings but the data will be reported as aggregated data. The audiotapes will be erased after transcription.

Volunteering to Be Part of this Research Study

- Participation in the evaluation study of the program is completely voluntary. You are free to participate in this research study or to withdraw at any time.
- If you choose not to participate, or if you withdraw, there will be no penalty or loss of benefits that you are entitled to through the date you exit the study nor will your academic status be affected in any way.

Questions and Contacts

- If you have any questions about this research study, contact Tesfaye Demissie 0912134486 e-mail tesfayedh07@yahoo.com
- If you have questions about your rights as a person who is taking part in a study, Call Natural and computational Science college head

Investigator Statement

I have carefully explained to the subject the nature of the above protocol. I hereby certify that to the best of my knowledge the subject signing this consent form understands the nature, demands, risks and benefits involved in participating in this study.

Name and Phone number of investigator:

Tesfaye Demissie Hailegebreal +251912134486/+251116815231

Consent, Right to Receive a Copy:

I agree that:

- I have fully read this informed consent form describing a research project.
- I have had the opportunity to question one of the persons in charge of this research and have received satisfactory answers.
- I understand that I am being asked to participate in research. I understand the risks and benefits, and I freely give my consent to participate in the research project outlined in this form, under the conditions indicated in it.

You are voluntarily making a decision whether or not to participate in this research study.

Your signature certifies that you have decided to participate having read and understood the information presented. You will be given a copy of this consent form to keep.

Check and initial if you agree to be video during the Focused group discussion).

Name and Phone number of investigator: +251912134486/+251116815231

e-mail tesfayedh07@yahoo.com

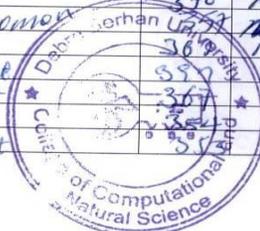
Hailegebreal T.D. (Tefaye Demissie Hailegebreal), Doctoral Candidate, Principal Investigator

No	Name of the student	ID	Sex	Semester	Signature	Date
1	Wainshet Belayhun	446	M	First		2/7/2010
2	Kinfet Fetene	429	M	1st		"
3	Tsedalu Dertaw	445	M	1st		2/7/2010
4	DEMREW ZAKEM	412	M	1st		"
5	Sintayehu Kebede	440	M	1st		"
6	Snewye Berihun	439	M	1st		"
7	Beshah Gezahach	409	M	I		"

7

8	TESFAY TESFALEM	442	M	I	TWSC	217/2010
9	Amsale Melese	405	F	J	AWA	217/2010
10	Zenayat Tesfome	451	F	I	AWA	217/2010
11	Gashaw Zewdu	418	M	I	AWA	217/2010
12	Belay Megash	408	M	I	AWA	217/2010
13	Ababa Mijatir	399	M	J	AWA	217/2010
14	Almaso Negesse	406	F	J	AWA	217/2010
15	Adem Nuhu Mohammed	401	M	I	AWA	217/2010
16	AHMED ALI EBRAHIM	403	M	I	AWA	217/2010
17	Abraham Tibebu	400	M	I	AWA	217/2010
18	Gedefaw Woyede	419	M	I	AWA	217/2010
19	Gormesaw Tefaye	423	M	I	AWA	217/2010
20	Kindew Demssie Dejen	428	M	I	AWA	217/2010
21	ABDU SEID YSIN	398	M	I	AWA	217/2010
22	Desile EZEZ	413	M	I	AWA	217/2010
23	Fekade massive	417	M	I	AWA	217/2010
24	Atili Tefayo	407	F	J	AWA	217/2010
25	Genzene Ababa	420	F	J	AWA	217/2010
26	Enatenesh Astam	415	F	J	AWA	217/2010
27	Asegdew AKIILU	406	M	I	AWA	217/2010
28	Mekonnen Akalu	431	M	I	AWA	217/2010
29	Hailmariam	425	M	I	AWA	217/2010
30	ESHET ABEBE	416	M	I	AWA	217/2010
31	Dawit Meronnen	411	M	I	AWA	11
32	DAGNA BEKELE BANIRU	410	M	I	AWA	11
33	Seid Abdu	437	M	I	AWA	11
34	Mohammed Awol seid	433	M	I	AWA	11
35	Zibaj Tilahun	430	M	J	AWA	11
36	Amatech MULVORUM	404	F	J	AWA	11
37	Destaye Alemnew	414	F	J	AWA	11
38	Samiru Yemanu	433	M	I	AWA	11
39	Hanklign Kindew	426	M	I	AWA	11
40	Nigussie Gete	435	M	I	AWA	11
41	Mulualem Alene	434	M	I	AWA	11
42	Kossa Berihun	427	M	I	AWA	11
43	Tefaye Tsehemel	411	M	J	AWA	11
44	Zehara Mohammed	452	F	I	AWA	11
45	Shinteyehu Kebede	440	M	I	AWA	11
46	Elias Demsie	370	M	I	AWA	11
47	BIRHANEMSEL SELAMORHAN	367	M	I	AWA	217/2010
48	Burhanu Asbu	367	M	I	AWA	11
49	Echene Lalukit	367	M	I	AWA	11
50	Getasewe Mihert	367	M	I	AWA	11
51	BELAY TAYE	367	M	I	AWA	11
52	Asrat yehualashet	367	M	I	AWA	11

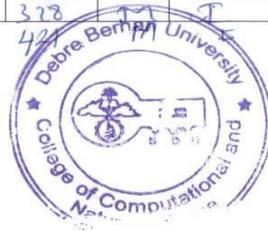
C=2



51	Abroraw Sendeke	344	M	I	As	2/7/2010
52	Lemlem negusie	376	F	I	As	11
53	Fikraddis Alemnew	365	F	I	As	27
54	Abebayeh hyleye	383	M	I	As	27
55	Adisu Jemene	346	M	I	As	22
56	Adebabay Hinafu	345	M	1 st	As	27
57	MURU TATU	382	M	1 st	As	27
58	meseretion mtd	381	M	IST	As	11
59	Ebrahim Xusef	361	M	IST	As	11
60	Abdu Mtd	342	M	I	As	11
61	Birara meikamu	356	M	I	As	2/7/2010
62	Simegaw Melkamu Haile	386	M	I	As	27
63	Wolelaw Halka	393	M	I	As	27
64	MOGES meya	379	M	I	As	27
65	MESAFINT ALEMNEW	378	M	I	As	27
66	Tibrel Mtd	373	M	I	As	11
67	Kelem TIRAZU	374	M	I	As	11
68	HALEMARIAM Garaw	371	M	I	As	11
69	Abraham Demrise	288	M	I	As	2/7/2010
70	Abaye Ababi	286	M	I	As	11
71	Anbichew Destaw	290	M	I	As	11
72	Adem Ali	290	M	I	As	11
73	Abdulkader Fiteh Abce	287	M	I	As	11
74	Amareem Alemnew	293	F	I	As	11
75	Merem nigussie	325	F	I	As	11
76	toyba yessut	337	F	I	As	11
77	Selama	330	F	I	As	11
78	Amas Alemu	291	M	I	As	2/7/2010
79	Seh3 WUBR HUS	329	M	I	As	11
80	Geenet Moyer	315	M	I	As	27
81	Kadiw Bate	320	M	I	As	27
82	Yohannes Minote	341	M	I	As	27
83	Habtull Gito	317	M	I	As	27
84	Kindis MASSERIE	321	M	I	As	55
85	BanteAmiak Trsfaw	297	M	I	As	11
86	Tesfu Gebey	335	M	I	As	11
87	Muhammad GIZAM	328	M	I	As	11
88	Teklu Tasew	421	M	I	As	11

C/ #

Total 90



38

Appendix B:

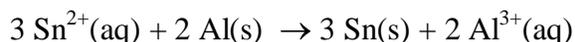
The pre and post test question

Name _____

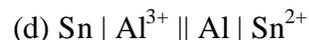
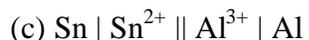
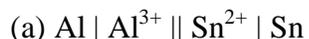
No _____

Instruction; - For the multiple question choose and encircle the letter of your choice and write a short answer on the given blank space.

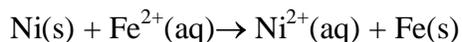
1. Consider an electrochemical cell where the following reaction takes place:



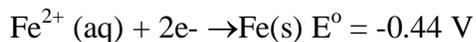
Which of the following is the correct cell notation for this cell?



2. Determine the cell potential for



Where $[\text{Ni}^{2+}] = 0.60 \text{ M}$ and $[\text{Fe}^{2+}] = 0.0030 \text{ M}$ using the following standard reduction potentials.



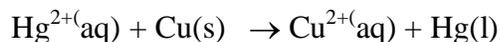
(a) +0.76 V

(b) -0.19 V

(c) -0.26 V

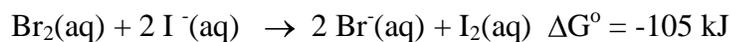
(d) -0.12 V

3. E° for the following redox reaction is -0.029 V.



- (a) -1.20 V (b) +0.52 V
(c) +1.20 V (d) -0.52 V

7. The following redox reaction can be used to form iodine.



What is E° for this reaction?

- (a) +1.09 V (b) -1.09 V
(c) +0.0011 V (d) +0.545 V

8. An electrochemical cell is constructed with two iron electrodes. The solution in the left hand compartment of the cell has 1.0 M $\text{Zn}^{2+}(\text{aq})$ while the solution in the right hand compartment contains 0.10 M $\text{Zn}^{2+}(\text{aq})$.

Which of the following is true about the cell?

- (a) No current flows through the wire connecting the electrodes
(b) Both electrodes are oxidized
(c) Reduction occurs in the left hand compartment
(d) Reduction occurs in the right hand compartment

9. How many coulombs of charge are required to deposit 1.00 g Ag from a solution of $\text{Ag}^{+}(\text{aq})$?

- (a) 9.27×10^{-3} (b) 894
(c) 1790 (d) 1.00

10. If we wish to convert 1.00 g of $\text{Au}^{3+}(\text{aq})$ ion into $\text{Au}(\text{s})$ in a "gold-plating" process, how long must we electrolyze a solution if the current passing through the circuit is 2.00 amps?

(a) 245 sec

(b) 0.50 sec

(c) 0.015 sec

(d) 735 sec

11. If we electrolyze a solution of $\text{Ni}^{2+}(\text{aq})$ to form $\text{Ni}(\text{s})$ and use a current of 0.15 amps for 10 minutes, how many grams of $\text{Ni}(\text{s})$ are produced?

(a) 0.027 g

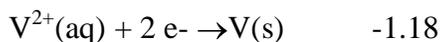
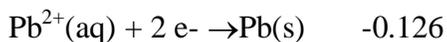
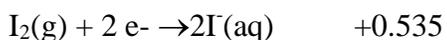
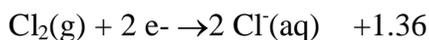
(b) 0.054 g

(c) 4.56×10^{-4} g

(d) 5280 g

12. Consider the following half reactions:

HALF REACTION $E^\circ(\text{V})$



(i) Which is the weakest oxidizing agent in the list? _____

(ii) Which is the strongest oxidizing agent? _____

(iii) Which is the strongest reducing agent? _____

(iv) Which is the weakest reducing agent? _____

(v) Will $2\text{I}^-(\text{aq})$ reduce $\text{Cl}_2(\text{aq})$ to $2\text{Cl}^-(\text{g})$? _____

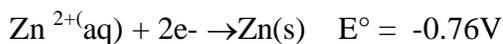
(vi) Name the elements or ions that can be reduced by $\text{Pb}(\text{s})$. _____



Adapted from

http://www.youtube.com/watch?feature=player_detailpage&v=yMMrJTE3pyM#t=111s

13. Consider the above diagram



(i) What is E° for the cell?

(a) -0.04 V

(b) -1.56 V

(c) +1.56V

(d) +0.40 V

(ii) Which is the cathode?

(a) Ag

(b) Zn

(iii) Which statement below is true?

(a) Electrons flow from Ag to Zn in the external wire, and NO_3^- ions in the salt bridge

move toward the Zn^{2+}/Zn compartment.

(b) Electrons flow from Ag to Zn in the external wire, and NO_3^- ions in the salt bridge move toward the $2\text{Ag}^+ / 2\text{Ag}$ compartment.

(c) Electrons flow from Zn to Ag in the external wire, and NO_3^- ions in the salt bridge move toward the $\text{Zn}^{2+} / \text{Zn}$ compartment.

The above questions are adopted from <http://www.hsh.k12.nf.ca>

Courses.umass.edu/www.electrochem.org/ and employees.oneonta.edu

Appendix C:

The schedule responses of students

No	To what extent would you agree with the following statements	Number of respondents according to their choices					Average	Percentage
		Strongly disagree (1)	Disagree (2)	I have no idea (3)	Agree (4)	Strongly agree (5)		
1	Students are interested to learn chemistry	2	4	-	22	62	4.53	93.3
2	The student-centered method of teaching is effective to teach all lesson of chemistry	22	29	2	22	15	2.9	41.1
3	Chemistry students do not score very well if they learn chemistry by traditional method of teaching.	10	8	5	27	40	3.88	74.4

4	The participation of the students is not very good with traditional way of teaching	1	15	3	35	36	4	78.9
5	My university teachers do not use animation, simulation and video in chemistry lesson.	8	12	4	41	25	3.7	73.3
6	The students can acquire clear concepts if they learn chemistry lessons supported by simulation, animation and video.	1	3	2	28	56	4.5	93.3
7	Learning supported with simulation, animation and video, enable students to recall main points easily.	2	2	1	25	60	4.54	94.4

8	Learning the abstract or complex lesson of chemistry through simulation and animation integrated with student-centred method is clear and understandable.	3	3	2	28	54	4.4	91.1
9	Virtually seeing the abstract or complex lesson enable the student to remember the main points	2	4	2	29	53	4.4	91.1
10	Learning through animation, simulation and video reduces the abstract nature of the lesson.	-	2	-	42	46	4.36	97.7
11	Learning through animation, simulation or video reduces the	-	1	-	35	54	4.56	98.8

	complexity of the lesson?							
12	Virtually seeing the motion, interaction of particles and changes of state contributes to make easy the lessons.	1	7	2	40	40	4	88.8
13	Students do not relate the chemistry lesson with their personal goals.	37	22	9	10	12	2.4	24.4
14	Most of the students do not relate the lesson they have learnt to the real world.	37	25	2	20	6	2.26	28.8
15	Learning through simulation, animation or video increases the interests of students to learn chemistry.	3	2	3	25	57	4.42	91.1

16	Learning with PBT (i.e. animation, simulation and video integrated with student-centred approach) increases the quality of learning chemistry.	1	5	3	26	55	3.8	90
17	The chemistry I learn will be helpful to my day- to-day activities and various aspects in my life.	1	2	-	25	62	4.6	96.7
18	The chemistry I learn is more important to me than the grade I receive.	2	3	-	10	75	4.7	94.4
19	Being a chemistry student understanding the chemistry courses gives me a sense of accomplishment.	1	-	1	25	63	4.7	97.8

Appendix D:

The schedule responses of the lecturers

No	To what extent would you agree with the following statements	Number of respondents according to their choices					Average	Percentage
		Strongly disagree (1)	Disagree (2)	I have no idea (3)	Agree (4)	Strongly agree (5)		
1	Students are interested to learn chemistry	1	2	-	4	5	3.8	75
2	The student-centred method of teaching is effective to teach all lesson of chemistry.	3	5	-	2	2	2.6	33.3
3	Chemistry students do not score very well when they learn chemistry by the traditional methods of teaching.	1	3	-	3	5	3.7	67

4	The participation of the students is not very good with traditional ways of teaching	1	2	-	5	4	3.8	75
5	My university teachers did not use animation, simulation and video in some lesson.	-	1	2	5	4	4	75
6	The students can acquire clear concepts when they learn chemistry lessons supported by simulation, animation and video.	-	-	-	2	10	4.8	100
7	Learning, supported with simulation, animation and video, enable students to recall the main	-	-	-	2	10	4.8	100

	points easily.							
8	Learning the abstract or complex lesson of chemistry through simulation and animation integrated with student-centred method is clear and understandable.	-	-	-	2	10	4.8	100
9	Virtually seeing the abstract or complex lessons enables the student to remember the main points.	-	1	-	2	9	4.6	91.6
10	Learning through animation, simulation and video reduces the abstract nature of the lesson.	-	-	-	3	9	4.8	100
11	Learning through animation, simulation or video reduces the	-	-	-	3	9	4.8	100

	complexity of the lesson?							
12	Virtually seeing the motion, interaction of particles and changes of state contributes for easiness of the lesson?	1	1	4	5	1	3.3	50
13	Students do not relate the chemistry lesson with their personal goals.	1	2	2	5	2	3.7	58
14	Most of the students do not relate the lesson they have learnt to the real world.	2	1	3	4	2	3.8	50
15	Learning through simulation, animation or video increases the interests of students	-	-	-	2	10	4.8	100

	to learn chemistry.							
16	Learning with PBT (i.e. animation, simulation and video integrated with student-centred approach) increases the quality of learning chemistry?	-	-	-	2	10	4.8	100

Appendix E:

The pre and post test result of students

ID NO	Control group			IDNo	Experimental group		
	Pre test	Post test	Difference		Pre test	post test	Difference
318	5	11	6	286	6	10	4
321	5	11	6	288	5	13	8
323	6	10	4	290	4	12	8
328	6	8	2	293	5	15	10
344	5	9	4	294	5	13	8
346	4	8	4	295	5	14	9
348	5	7	2	298	5	12	7
352	5	10	5	304	5	14	9
356	4	8	4	305	7	14	7
360	4	8	4	306	5	17	12
365	10	12	2	310	4	13	9
367	5	9	4	312	2	14	12
370	6	8	2	313	6	15	9
371	0	9	9	315	0	16	16
374	5	10	5	316	4	13	9
379	6	8	2	319	0	12	12
380	6	9	3	322	3	12	9
386	2	8	6	331	5	14	9
390	5	10	5	330	5	16	11
391	4	9	5	333	8	14	6
393	3	12	9	334	6	15	9
396	4	10	6	335	0	14	14
397	0	7	7	338	5	15	10
404	5	10	5	339	5	15	10
405	5	10	5	341	4	16	12
407	4	9	5	345	6	14	8
409	8	11	3	350	5	13	8
412	5	12	7	353	7	14	7
415	6	7	1	355	5	13	8
419	3	9	6	358	5	15	10
420	0	8	8	362	5	13	8
425	6	12	6	369	5	13	8
426	5	9	4	385	5	12	7
427	2	10	8	389	4	17	13
428	7	10	3	399	4	15	11
429	5	9	4	400	0	12	12

431	2	11	9	401	5	14	9
434	7	9	2	408	5	16	11
437	5	9	4	410	5	13	8
440	5	10	5	413	7	12	5
444	5	9	4	416	5	14	9
446	5	12	7	417	4	12	8
452	5	12	7	418	6	15	9
432	5	7	2	423	5	16	11
451	5	12	7	428	0	11	11
Sum	210	428	218		202	622	420
Mean	4.666667	9.511111	4.844444		4.488889	13.82222	9.333333
SD	1.906925	1.516908	2.088448		1.902417	1.585286	2.286323

Appendix F:

Schedule to be filled by students

UNIVERSITY OF SOUTH AFRICA (UNISA)

Institute of Science and Technology Education

Department of Chemistry

Dear students

This questionnaire is designed to collect information to conduct a study entitled “Effects of Pedagogy-Based-Technology on Chemistry Student’s Performance in Higher Institution of Ethiopia: A Case Study at Debre Berhan University”

You are kindly requested to read each statement very carefully and frankly to express your opinion because your genuine responses are the meanest to arrive at a reliable result.

Objectives

1. To investigate the effects of pedagogy-based- technology on student’s performance with chemistry lessons such as Electrochemistry for second year chemistry students.
2. To assess the opinion of chemistry teachers and students about the implementation of student-centred approach integrated with animation, simulation and video to teach chemistry at Debre Berhan University.
3. To suggest possible ways forward in chemistry teaching in Debre Berhan University

Be aware that the information got through this questionnaire is solely used for the research purpose and it will be strictly kept confidential.

Thank you for your cooperation in advance!

Part-I General information

Please fill the following blank spaces with appropriate answer.

1. Year /level/ _____

2. Sex _____

Part –II Specific information

Instruction: Remember the plasma TV lesson you have learned in grade 11 and 12 the movement of electron around the nucleus, the experimental demonstration, the chemical equilibrium, thermal equilibrium and so on. Some of them were simulation, some of them were animation and some of them were video. Based on these listed below are statements about the effects of simulation animation integrated with student-centred method on the student's performance.

Please read each statement carefully and indicate the extent to which you have agreed by encircling the letter of your choice.

Questions

1. Students are interested to learn chemistry?

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

2.Why? _____

3. The student-centred method of teaching is effective to teach all lesson of chemistry.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

4. Chemistry students do not score very well if they learn chemistry by traditional method of teaching.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

5. The participation of the students is not very good with traditional way of teaching.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

6.Why?_____

7. My university teachers do not use animation, simulation and video or either of them in some lesson of chemistry.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

8. The students can acquire clear concepts if they learn chemistry lessons supported by simulation, animation and video.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

9. Learning supported with simulation, animation and video, enable students to recall main points easily.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

10.How?_____

11. Learning the abstract or complex lesson chemistry through simulation and animation integrated with student-centred method is clear and understandable.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

12. What is the reason for this?

13. Virtually seeing the abstract or complex lesson enable the student to remember the main points.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

14.How? _____

15. Learning with animation, simulation and video reduces the abstractness of the lesson?

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

16. Learning through animation, simulation or video reduces the complexity of the lesson?

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

17. If your answer for number 15 and 16 is agree or strongly agree, what are the reasons?

18. Virtually seeing the motion, interaction of particles and changes of states contributes for easiness of the lesson.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

19. Students do not relate the chemistry lesson with your personal goals.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

20. Most of the students do not relate the lesson they have learnt to the real world.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

21. Learning through simulation, animation or video increase the interests of students to learn Chemistry.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

22. Learning with PBT (i.e. animation, simulation and video integrated with student-centred approach) increases the quality of learning chemistry?

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

23.How?_____

24. If you face a difficulties in learning chemistry, what do you think be the reasons?

25. The chemistry I learn will be helpful to my day to day activity with various aspects in my life.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

26. The chemistry I learn is more important to me than the grade I receive.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

27. Being a chemistry student understanding the chemistry courses gives me a sense of accomplishment.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

28. What do you think chemistry is about?

29. You have seen that both the traditional and student-centred way of teaching are not able to remove ambiguity of some lesson for many students. What do you think could be the reasons?

30. What was particularly good or bad about your chemistry learning experience?

31. Mention the status of educational technology in your campus?

32. What do you think that the challenges to integrate technology with pedagogy for chemistry learning?

Appendix G:

Schedule to be filled by lecturers

UNIVERSITY OF SOUTH AFRICA (UNISA)

Institute of Science and Technology Education

Department of Chemistry

Dear lecturers

This questionnaire is designed to collect information to conduct a research entitled “Effects of Pedagogy-Based-Technology on Chemistry Student’s Performance in Higher Institution of Ethiopia: A Case Study at Debre Berhan University”

You are kindly requested to read each statement very carefully and frankly to express your opinion because your genuine responses are the meanest to arrive at a reliable result.

Objectives

3. To investigate the effects of pedagogy-based- technology on student’s performance with chemistry lessons such as Electrochemistry for second year chemistry students.
4. To assess the opinion of chemistry teachers and students about the implementation of student-centred approach integrated with animation, simulation and video to teach chemistry at Debre Berhan University.
3. To suggest possible ways forward in chemistry teaching in Debre Berhan University

Be aware that the information got through this questionnaire is solely used for the research purpose and it will be strictly kept confidential.

Thank you for your cooperation in advance!

Part-I General information

Please fill the following blank spaces with appropriate answer.

1. Year of experience. _____

2. Qualification _____

3. Sex _____

Part –II Specific information

Listed below are statements about the effects of simulation animation integrated with student-centred method on the student's performance.

Please read each statement carefully and indicate the extent to which you have agreed by encircling your choice.

Questions

1. Students are interested to learn chemistry.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

2.Why? _____

3. The student-centred method of teaching is effective to teach all lesson of chemistry.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

4. Chemistry students do not score very well when they learn chemistry by traditional method of teaching.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

5. The participation of the students is not very good with traditional way of teaching.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

6. Why? _____

7. My university teachers do not use animation, simulation and video or either of them in some lesson of chemistry.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

8. The students can acquire clear concepts if they learn chemistry lessons supported by simulation, animation and video.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

9. Learning supported with simulation, animation and video, enable students to recall main points easily.

1. Strongly disagree 2. Disagree 3. I have no idea 4. Agree 5. Strongly agree

10. How? _____

11. Learning the abstract or complex lesson chemistry through simulation and animation integrated with student-centred method is clear and understandable.

1. Strongly disagree 2. Disagree 3. I have no idea 4. Agree 5. Strongly agree

12. What is your reason for this?

13. Visualizing the abstract or complex lesson enable the student to remember the main points.

1. Strongly disagree 2. Disagree 3. I have no idea 4. Agree 5. Strongly agree

14. How? _____

15. Learning with animation, simulation and video reduces the abstractness of the lesson?

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

16. Learning through animation, simulation or video reduces the complexity of the lesson?

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

17. If your answer for number 15 and 16 is moderately or completely, what are the reasons?

18. Virtually seeing the motion, interaction of particles and changes of state contributes for easiness of the lesson.

1. Strongly disagree 2. Disagree 3.I have no idea 4.Agree 5. Strongly agree

19. Students do not relate the chemistry lesson with their personal goals.

1. Strongly disagree 2. Disagree 3. I have no idea 4. Agree 5. Strongly agree

20. Most of the students do not relate the lesson they have learnt to the real world.

1. Strongly disagree 2. Disagree 3. I have no idea 4. Agree 5. Strongly agree

21. Learning through simulation, animation or video increase the interests of students to learn Chemistry.

1. Strongly disagree 2. Disagree 3. I have no idea 4. Agree 5. Strongly agree

22. Learning with PBT (i.e. animation, simulation and video integrated with student-centred approach) increases the quality of learning chemistry?

1. Strongly disagree 2. Disagree 3. I have no idea 4. Agree 5. Strongly agree

23. Why? _____

24. If the students faces difficulties in learning chemistry, what do you think be the reasons?

25. Have you ever thought about how the chemistry students learn will be helpful to them with various aspects?

26. How? _____

27. What do you think chemistry is about?

28. You have seen that both the traditional and student-centred way of teaching are not able to remove ambiguity of some lesson for many students. What do you think could be the reasons?

29. What was particularly good or bad about your chemistry teaching experience?

30. Mention the status of educational technology in your campus?

31. What do you think that the challenges to integrate technology with pedagogy for chemistry learning?

32. If you have any suggestion concerning the idea mentioned above suggest it

Appendix H:

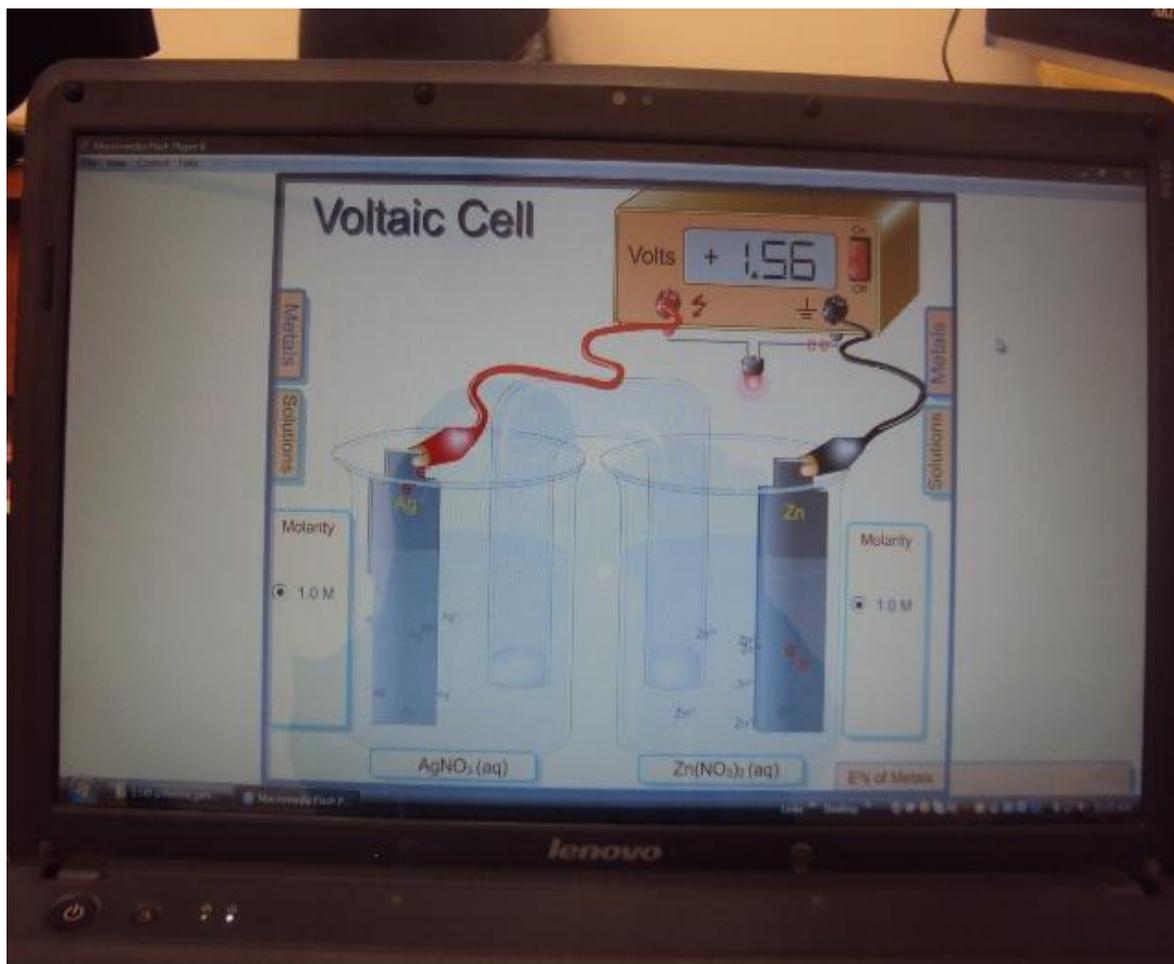
Focus group question prepared for students and Lecturers

That can be performed separately

1. Why do you think studying chemistry is important?
2. What kinds of topics in chemistry are more interesting to you?
3. Why do you think that the students fear to join the science stream specifically chemistry department?
4. What course work of chemistry do you find most challenging and difficult?
5. What do you think mainly reduces the quality of chemistry learning?
6. What is the importance of Technology in enhancing chemistry learning? How?
7. How can we make easy and attractive the chemistry learning?

Appendix I:

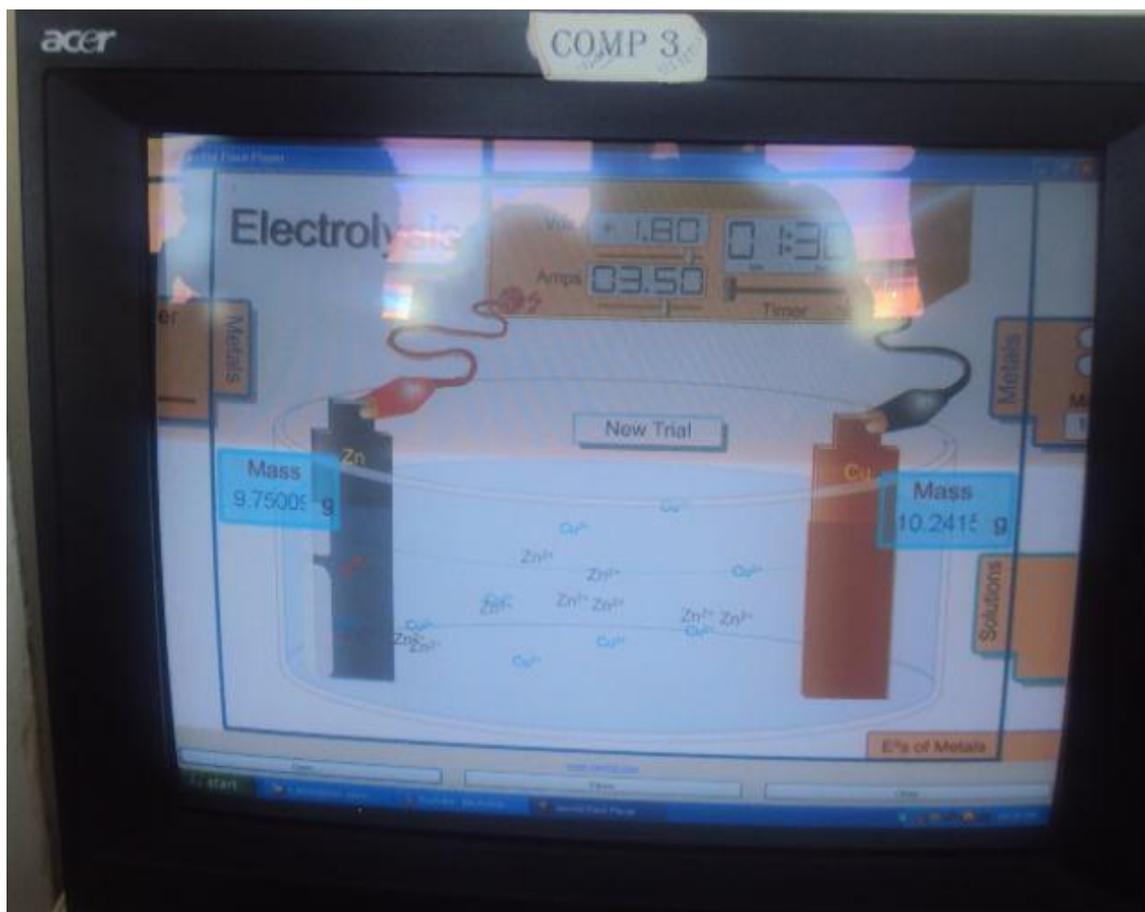
Voltaic cell shows the motion of ions in a solution



Voltaic cell shows the motion of ions in a solution and in the salt bridge, the direction and motion of electrons in the electrodes as well as in the wire. Adopted from www.chem.iastate.edu/group/Greenbowe/.../animationsindex.htm

Appendix J:

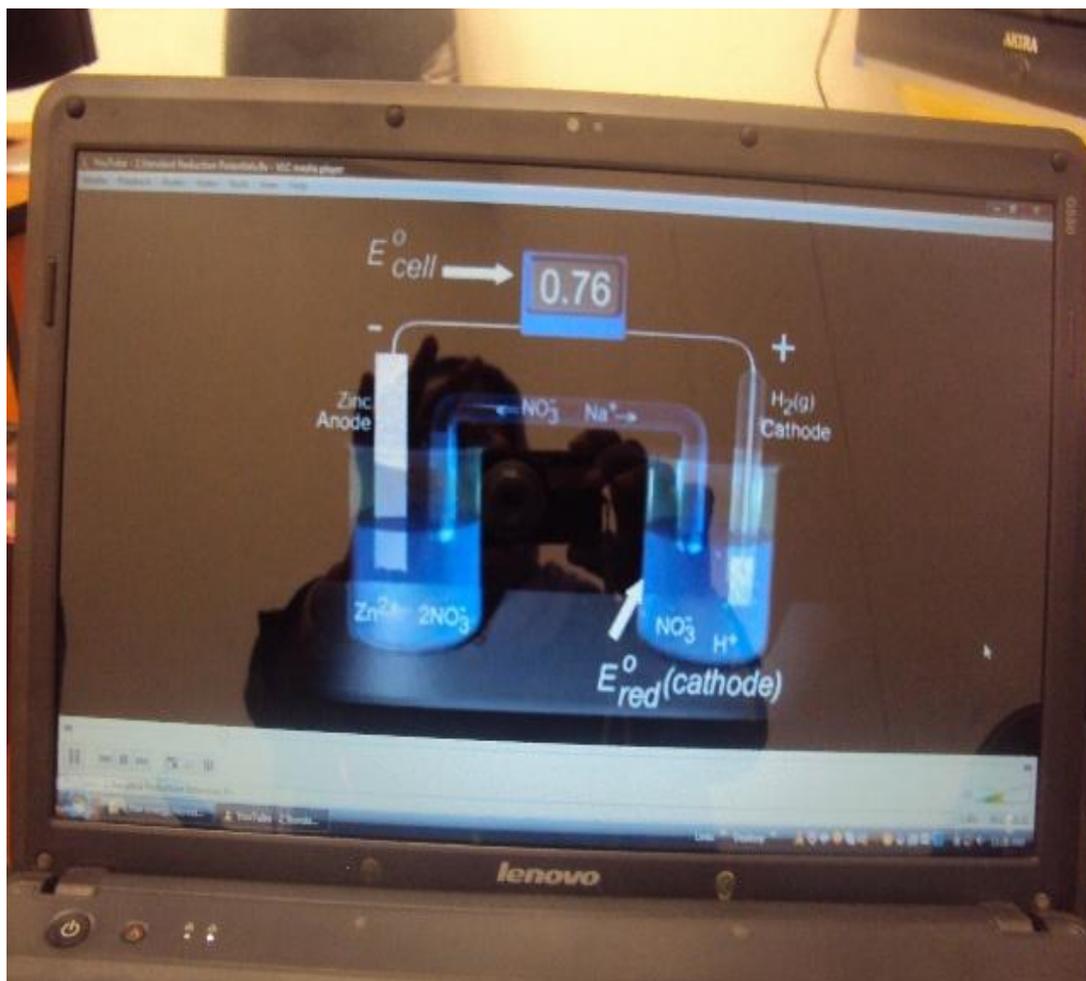
Electrolytic cell shows the motion of ions in a solution



Electrolytic cell, which shows the motion of ions in a solution, the direction and motion of electrons in the electrodes as well as in the wire. adopted from www.chem.iastate.edu/group/Greenbowe/.../animationsindex.htm

Appendix K:

Voltaic cell showing the motion of ions in a solution and in the salt bridge



Voltaic cell showing the motion of ions in a solution, in the salt bridge, the direction and motion of electrons, in the electrode as well as through the wire with a reference electrode adopt from

www.chem.iastate.edu/group/Greenbowe/../animationsindex.htm

Appendix L:

The chemistry experts' belief on pre-post tests contents of electrochemistry in measuring the planned concepts

Question number	The given alternative			
	Unsatisfactory	Satisfactory	Good	Very good
1				3
2				3
3				3
4				3
5				3
6				3
7		1	2	
8				3
9			1	2
10		1	1	1
11				3
12				3
13				3

Appendix M:

The belief of psychology and pedagogy experts on the content of the schedule

	The schedule to be filled by lecturers				The schedule to be filled by students			
Question number	The given alternatives				The given alternatives			
	Unsatisfactory	Satisfactory	Good	Very good	Unsatisfactory	Satisfactory	Good	Very good
1				4				4
2			1	3			1	3
3				4				4
4				4				4
5				4				4
6				4				4
7			2	2			2	2
8				4				4
9			2	2			2	2
10				4				4
11				4				4
12				4				4
13			2	2			2	2

14				4				4
15		1	1	2		1	1	2
16				4				4
17				4				4
18				4				4
19				4				4
20				4				4
21		1	1	2		1	1	2
22				4				4
23				4				4
24				4				4
25				4			2	2
26				4			2	2
27				4		1	2	2
28				4				4
29				4				4
30				4				4
31				4				4
32				4				4

Appendix N:

Pilot study performance

No	Control group		Experimental group	
	Pre test	Post test	Pre test	Post test
1	5	12	5	15
2	5	12	5	16
3	6	13	5	16
4	6	14	6	17
5	6	14	6	17
6	7	15	7	18
Sum	35	80	34	99
Mean	5.833333	13.33333	5.666667	16.5
SD	0.752773	1.21106	0.816497	1.048809