YANGON INSTITUTE OF EDUCATION

A STUDY OF THE EFFECTS OF ACTIVITY-BASED LEARNING ON GRADE TEN STUDENTS IN TEAHCING CHEMISTRY

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PM 11

2014

A STUDY OF THE EFFECTS OF ACTIVITY-BASED LEARNING ON GRADE TEN STUDENTS IN TEACHING CHEMISTRY

by

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A thesis submitted to the Board of Examiners in the Department of Methodology, Yangon Institute of Education, in partial fulfillment of the requirements for the degree of
MASTER OF EDUCATION

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Acknowledgements

I would like to offer respectful thanks to Dr. Aung Min (Rector, Yangon Institute of Education), Dr. Ko Ko Kyaw Soe (Pro-Rector, Yangon Institute of Education) and Dr. Khin Myo Myint Kyu (Pro-Rector, Yangon Institute of Education) for their permission to conduct the study. I would like to express my special thanks to Professor Dr. Soe Than (Head of Methodology Department, Yangon Institute of Education) who lovingly and patiently guided me throughout this study.

My sincere thanks go to my external examiner, Daw Aye Aye Kywe (Retired Associate Professor, Department of Methodology, Yangon Institute of Education) for her enthusiastic guidance on my study. Special thanks also go to my supervisor, Dr. Ma Kyi Swe (Assistant Lecturer, Department of Methodology, Yangon Institute of Education) for her great kindness, exhaustic supervision, precious guidance and continuous encouragement in editing and reviewing my thesis during the study to complete successfully.

I am very grateful to my secretary, Dr. Khin Mu Mu Han (Assistant Lecturer, Yangon Institute of Education) who gave me expert guidance to be a successful thesis. Moreover, I am also grateful to Professor Dr. Thein Thein Win (Head of Chemistry Department, Yangon Institute of Education) and Daw Tin Marlar (Associate Professor, Department of Chemistry, Yangon Institute of Education) who suggested the questionnaires for validation.

I would also like to thank all my teachers for their valuable encouragement and comments on the thesis and also friends for their love, encouragement and assistance.

I am much obliged to the librarians and staffs of Yangon Institute of Education, Yangon University of Distance Education, the Baldwin Library, American Center, Universities' Central Library and the United Nations Information Center in Yangon for their patient help in conducting this study. Special thanks also go to all of the participants in this study. Last but not the least, I would like to thank my beloved father and mother, and my siblings and relatives for their unstinting support and kindness that enabled me to work towards this study. Without their help this study would not have been accomplished smoothly.

Abstract

The purpose of this study is to compare students' chemistry achievement between activity-based learning and traditional teacher-led instruction in Grade Ten chemistry teaching. Activity-based learning is learning that requires the learner to do something more than look at and listen to a teacher. Two schools, namely No. (2), Basic Education High School, Lanmadaw in Yangon Region and (Sub) Basic Education High School, Ayoda in Ayeyarwaddy Region were used in this study. Quantitative study was conducted to obtain the required data. In this study, Pretest-Posttest Control Group Design of experimental research was selected. The sample sizes were (60) students from No. (2), BEHS, Lanmadaw and (52) students from (Sub) BEHS, Ayoda. The experimental group was taught with the help of activities whereas the control group was taught the same lessons through traditional teacher-led instruction. Independent samples *t*-test was used to analyze whether there was a significant difference between the two groups. The results showed that the students who received the treatment by activity-based learning were significantly better than those who received the treatment by traditional teacher-led instruction for No. (2), BEHS, Lanmadaw (t = 4.74, df = 58, MD = 11.33, ***p >.001). The findings of this study had established the fact that activity-based learning can be used to improve chemistry teaching methodology at the high school level. Activity-based learning is a useful method for students to contextualize their learning, acquire social skills, thinking skills and academic skills. Moreover, activity-based learning can also be used to teach many students with disabilities.

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CHAPTER 1

Introduction

The future of a nation is safe in the hands of educated individuals. Education refers to " all actions and influences " directed to developing and cultivating a person's mental abilities, knowledge, skills, attitudes and behavior in such a way that the individual's personality may be developed to the fullest possible extent. So, the central task of education is to implant a will and facility for learning.

Chemistry is close to a nation's health and strength and to the well-being of its people. It touches the lives of every individual. Scientific discoveries, technological advances, the efficiency of the work force, the exercising of citizens' rights and the quality of life are directly tied to the teaching of chemistry. Chemistry teaching is not high enough in quality unless it has an effective laboratory component and sufficient opportunity for students to solve mathematical and intellectual problems. The aims of teaching chemistry are to enable students to acquire knowledge, intellectual abilities, experimental skills and interest in chemistry. To achieve these aims, the methods of teaching employed in teaching-learning situations are of vital importance. The statement that "anyone who knows his subject can teach it" can be misleading. Actually, every teacher needs to prepare himself in subject matter and in method.

Method of teaching is the overt expression of educational aims. It includes a series of action or steps taken by a teacher to achieve a certain teaching and learning objective. Methods are used by the teacher to create learning environments and specify the nature of the activity in which the teacher and the learners will be involved during the lesson. Most good teachers find effective methods by selecting what they consider the best from the numerous sources available. Good teaching will adapt methods, activities, assignments and advice to each learner based on an understanding of his unique characteristics.

The intent of teaching is learning. Learning is an active process. It is achieved through a variety of activities and is approached through a variety of avenues: reading, listening, asking questions, working with material objects, etc. The only thing which all these activities need to involve is thinking. Integrating activity-based learning elements is thus a promising way to enhance students' learning experiences.

1.1 Background of the Study

Activity-based learning emphasizes on what the students do. It is a child-centered approach. It describes a range of pedagogical approaches to teaching. Its core premises include the requirement that learning should be based on doing some hands-on experiments and activities. The idea of activity-based learning is rooted in the common notion that students are active learners rather than passive recipients of information. If the students are provided the opportunity to explore by themselves and provided an optimum learning environment, learning becomes joyful and long-lasting. The key feature of the activity-based learning method is that it uses child-friendly educational aids to foster self-learning and allows students to study according to their aptitude and skill. An activity-based learning is the acquirement of schematic concepts through activities that involve the task or concepts to be learned.

The idea of activity-based learning follows the constructivist educational theory and is child-centered pedagogy (Hariharan, 2011). Activity-based learning may be defined as a method of instruction, where activities of different types suitable and relevant to specific subjects are integrated seamlessly into the regular instructional materials and methods to involve students in the teaching-learning processes and engage them fruitfully.

Activity-based learning was started by a British man called David Horsburgh in 1944. He was an innovative thinker and charismatic leader. He started teaching in Rishi Valley School. He joined the British Council and worked in Chennai and Bangalore for many years. After his voluntary retirement, he located a 7-acre (28,000 m^2) site in Kolar District and opened his school, Neel Bagh. Neel Bagh was based on an innovative idea of Horsburgh and known for its creative methods in teaching well-planned learning materials. He had vertical grouping in the classroom and the children worked on the material on cards, at their specific level. These pedagogic materials were systematically planned, with sketches and drawings and an occasional touch of humour. Then, Horsburgh endowed Neel Bagh with a magnificent library that was accessible to teachers and students. This initiative of Horsburgh was later proved to be one of the pioneer and milestones in activity-based learning. Thus, activity-based learning is the method of education followed in the Corporation schools of Chennai, from 2003, as an effort to provide special schools for children who had been freed from bonded labour. Gallagher and Stepien, (1996, cited in Khan) found no significant difference on "short-term retention" assessment between students of activity-based learning and traditional student.

In chemistry, several activities such as activity card had been used so as to observe students' understanding of "Elements and Compounds" unit (Duvarci, 2010). The findings of the study clearly show that student-centered teaching approaches, specifically activity-assisted teaching, have many advantages for teaching of the chemistry topics. The study is investigated the effects of the activity-assisted teaching on only one topic and class. However, it still provides some significant implications for teaching chemistry.

Moreover, chemistry can be related to the lives of all students, and it is essential to preparing students for the transition to adulthood and for membership in an increasingly technological workforce (Fradd, 1995, cited in Salend, 2001). Chemistry education can help students learn about real environments in which they live and develop a multicultural world views of scientific phenomena. Consequently, it is important to study the effects of activity-based learning on Grade Ten students in teaching chemistry.

1.2 Purposes of the Study

The purposes of this study are as follows:

- To develop activity-based learning performance model in Grade Ten chemistry teaching
- To compare students' chemistry achievement between activity-based learning and traditional instruction at the Grade Ten chemistry teaching
- To find out the effects of activity-based learning at the high school level chemistry teaching
- To provide suggestions for improving chemistry teaching methodology

1.3 Statement of Hypotheses

- There is a significant difference between the activity-based learning group and the traditional instruction group in chemistry achievement.
- There is a significant difference between the activity-based learning group and the traditional instruction group on the scores of knowledge level questions.
- There is a significant difference between the activity-based learning group and the traditional instruction group on the scores of comprehension level questions.
- There is a significant difference between the activity-based learning group and the traditional instruction group on the scores of application level questions.

1.4 Scope of the Study

The following points are the scope of the study:

- This study is geographically restricted to Yangon Region and Ayeyarwaddy Region.
- One Basic Education High School from Yangon Region and one (Sub) Basic Education High School from Ayeyarwaddy Region are selected for this study. Participants in this study are Grade Ten students from the selected schools within the academic year (2013-2014). In the first school, 60 students are included and in the second school, 52 students are selected.
- The content area is limited to two chapters such as Chapter (14) Acids, Bases and Salts, and Chapter (15) Carbon and its Compounds, from Grade Ten chemistry textbook to investigate the students' chemistry achievement.

1.5 Definitions of Key Terms

Activity-based learning: Activity-based learning is learning that requires the learner to do something more than look at and listen to a teacher (Rowntree, 1982).

Chemistry: Chemistry is a science that examines the properties, composition, structure, and changes of matter (Kask, 1993).

1.6 Significance of the Study

The teachers in schools use a teacher-centered method by which they plan, implement and evaluate their lessons. In the teacher-centered learning environment, the teachers are the main persons which lead the teaching. They give the lectures while students sit quietly and take notes. Lecturing is probably the oldest teaching method and remains the most common form of instruction. The teachers can convey personal enthusiasm in a way that no book or other media can. Enthusiasm stimulates the interest of the students. In a lecture, large amounts of factual material can be taught. On the other hand, since the students listen to the teacher without doing anything, they are passive learners. Besides, the lectures are not well suited to complex, detailed, or abstract materials, and tend to be forgotten quickly. Actually, the students need to do something more than look at and listen to their teacher.

Another one is a student-centered method that prides itself on making the teachers find new ways to engage the students within the subject material through hands-on experience and rich group activities. In a student-centered classroom, the students often work in teams, and even if they're not particularly interested in the subject matter, their assigned roles within their teams will keep them busy and their thoughts occupied. According to Moon (1996), education should equip everyone with the desire and skills to participate in a democratic society. Democracy demands the involvement of everyone. Moreover, chemistry enables the students to understand what happened around them. Because chemistry topics are generally related to or based on the structure of matter, chemistry proves a difficult subject for many students. Chemistry curricula commonly incorporate many abstract concepts, which are central to further learning in both chemistry and other sciences (Taber, 2002, cited in Sirhan, 2007). These abstract concepts are important because further chemistry/science concepts or theories cannot be easily understood if these useful concepts are not sufficiently grasped by the students. Therefore, activity-based learning is suitable for teaching chemistry.

An integrated part of an activity-based approach is providing hands-on multisensory experiences and materials. Hands-on learning gives the students concrete experiences that establish a foundation for learning more abstract concepts. These kinds of activities also help the students actively explore and discover the content. Activity-based learning is depicted with a famous saying of Confucius that stresses participation as the key to the students' learning success as follows:

"Tell me, and I will forget,
Show me, and I may remember,
Involve me, and I will understand."

Hein (1991, cited in StoBlein, 2009) describes the vital learning principles of an activity-based learning as follows:

Learning

- is an active process,
- is engaging,
- is a social activity,
- occurs contextually,
- builds on previous knowledge, and
- takes time.

Learning activities provide opportunities for experiential learning which involves links between the thinking and the doing. Experiential learning involves a number of steps that offer the students hands-on, collaborative and reflective learning experience which helps them to "fully learn new skills and knowledge". Although learning content is important, learning from the *process* is at the heart of experiential learning.

In activity-based learning, the students examine learning requirements and think how to solve a problem in hand. They can get deep understanding, longer retention and a desire to learn more. Doing so makes the teaching-learning environment effective and efficient. Therefore, activity-based learning is essential for education.

References

Duvarci, D. (2010). *Activity-based Chemistry Teaching: A Case of "Elements and Compounds".* Retrieved October 16, 2013, from http://www.sciencedirect. com/ science/article/pii/S1877042810004027

Hariharan, P. (2011). *Effectiveness of Activity-based Learning Methodology for Elementary School Education.* Retrieved October 16, 2013, from http://www. ukfiet.org/sites/all/docs/Paper%20by%20S.%20Anandalakshmy.pdf

Kask, U., & Rawn, J. D. (1993). *General Chemistry*. London: Wm.C. Brown Communications, Inc.

Khan, M., Niaz Muhammad, Dr., Ahmed, M., Saeed, F., & Khan, S. A. (2012). *Impact of Activity-based Teaching on Students' Academic Achievements in Physics at Secondary Level*. Retrieved October 16, 2013, from http://www.savap. org.pk/journals/ARlnt./Vol.3%281%29/2012%283.119%29.pdf

Moon, B., & Mayes, A. S. (1996). *Teaching and Learning in the Secondary School*. London and New York: Open University.

Rowntree, D. (1982). *A Dictionary of Education*. New Jersey: Barnes & Noble Books- Totowa.

Salend, S. J. (2001). *Using an Activities-based Approach to Teach Science to Students with Disabilities.* Retrieved October 8, 2013, from www.catea. gatech.edu / scitrain /kb/ FullText- Articles /Salend-pdf

Sirhan, G. (2007). *Learning Difficulties in Chemistry*: *An Overview*. Retrieved October 8, 2013, from http:// www. tused. org.

StoBlein, M. (2009). *Activity-based Learning Experiences in Quantitative Research Methodology for Young Scholars-Course Design and Effectiveness*. Retrieved October 8, 2013, from www.pomsmeetings.org/ConfPapers/011/011-0782.pdf

CHAPTER 2

Review of Related Literature

Theoretical framework related to this study is presented in this chapter.

2.1 Theory of Cognitive Development

The word, cognition, means the process of knowing. Cognition involves conceptualizing, reasoning, thinking, and problem solving. Development refers to changes in the child that occur over time that follow a logical or orderly pattern that moves towards greater complexity and enhances survival (Meece, 2002). It is intimately linked with learning. Both learning and maturation may be thought of as components of development. At any given time, developmental level places constraints on learning possibilities: what, where, when, why, and how of learning.

Development proceeds from the infant's total reliance on sensation and motor activity for acquiring knowledge to the adolescent's capacities for generating hypotheses, anticipating consequences, and formulating logical systems of experimentation. It represents systematic and successive changes that enhance a child's overall adaptation to the environment. These changes are progressive and occur over the course of the life span. Cognitive theories emphasize the changing qualities of thinking and knowing from infancy through adulthood. Many developmental theories postulate that cognitive development involves construction of knowledge as a function of the individual's experiences (Schunk, 2004). The two cognitive-development theorists are Jean Piaget (1896 - 1980) and Lev Semenovich Vygotsky (1896 - 1934).

2.1.1 Piaget's Cognitive Development Theory

Swiss psychologist Jean Piaget developed a theory about how humans develop and make sense of their world. From Piaget's perspective, humans are always striving to make sense of their environment, and their biological maturation, their interaction with the environment, and their social experiences combine to influence how they think about things. According to Piaget, as children grow and mature, they pass through four stages of cognitive development. Younger children deal with their world in more concrete, hands-on ways, whereas older children and adults can engage in abstract problem solving (Arends, 2007).

Piaget believed that children act as "little scientists", trying to make sense of their world. His research focused primarily on how children acquire knowledge as they develop. He believed that cognitive development involves changes in a child's ability to reason about his or her world (Meece, 2002).

Piaget believed that cognitive development results from an interaction of the brain's biological maturation and personal experiences and provided a theory for understanding how people adapt to their environment through the processes of assimilation and accommodation. When individuals experience a new idea or a new situation, they first try to make sense of the new information by using existing schemata.

Schemata: Schemata refer to the way individuals store and organize knowledge and experiences in memory.

Assimilation: Trying to understand the new information by adapting it to what individuals already know is called assimilation.

Accommodation: If individuals cannot fit the new data or situation into their existing schemata, they must develop new concepts or schemata. This is called accommodation.

The primary contribution of Piaget's ideas for teachers is his stage model of cognitive development.

2.1.2 Piaget's Stage Model

Piaget observed children and listened to them reason as they tried to solve problems (Passer, 2007). He proposed that children' thinking changes *qualitatively* with age and that it differs from the way adults think. He presents four stages of cognitive development such as sensorimotor, preoperational, concrete operational, and formal operational. Each one is characterized by different patterns of logic and reasoning. At each new stage, the competencies of earlier stages are not lost, but integrated into a qualitatively new approach to thinking and knowing. It is important to note that the age ranges associated with the stage may not apply to every child. Some children may reach a particular stage earlier or later than the others.

1. Sensorimotor Stage: From birth to about age 2, infants in the sensorimotor stage understand their world primarily through sensory experiences and physical interactions with objects. Reflexes are infants' earliest schemas, and as infants mature, they begin to explore their surroundings and realize that they can bang spoons, take objects apart, and make things happen. So, they grasp the concept of **object permanence**, *the understanding that an object continues to exist even when it no longer can be seen.*

Infants begin to acquire language after age 1, and towards the end of the sensorimotor period they increasingly use words to represent objects, needs, and actions.

Thus in the space of 2 years, infants grow into planful thinkers who form simple concepts, solve some problems, and communicate their thoughts.

2. Preoperational Stage: At about age 2, children enter a preoperational stage, in which they represent the world symbolically through words and mental images but do not yet understand basic mental operations or rules. Rapid language development helps children label objects and represent simple concepts. Children can think about the past and future and can better anticipate the consequences of their actions. Symbolic thinking enables them to engage in make believe, or pretend play.

Despite these advances, the preoperational children's cognitive abilities have major limitations. They do not understand **conservation**, *the principle that basic properties of objects stay the same even though their outward appearance may change*. But children's thinking at this age displays **irreversibility**. It is difficult for them to reverse an action mentally. Moreover, they exhibit **centration**, *focusing on only one aspect of the situation.* They often display **animism**, *attributing lifelike qualities to physical objects and natural events.* In this stage, their thinking also reflects **egocentrism**, *difficulty in viewing the world from someone else's perspective*, and they believe that other people perceive things in the same way they do.

3. Concrete Operational Stage: From about ages 7 to 11, children in the concrete operational stage can perform basic mental operations concerning problems that involve tangible objects and situations. When concrete operational children confront problems that are hypothetical or require abstract reasoning, they often have difficulty or show rigid types of thinking. **Seriation** and **classification** are important in this stage. Seriation is the operation that allows children to arrange objects in terms of increasing or decreasing size. Classification is the operation that allows children to place objects into categories on the basis of shared characteristics.

4. Formal Operational Stage: Piaget's model ends with the formal operational stage, in which individuals are able to think logically and systematically about both concrete and abstract problems, form hypotheses, and test them in a thoughtful way. Formal operations act on ideas rather than on objects. Formal thinking begins around ages 11 to 12 and increases through adolescence. Children entering this stage begin to think more flexibly when tackling hypothetical problems, and typically enjoy the challenge. Piaget's stage model is presented in Table 2.1.

Table 2.1 Piaget's Stage Model

Stage	Appropriate Age	Characteristics
Sensorimotor	0-2 years	Begins to make use of imitation, memory, and thought. Begins to recognize that objects do not cease to exist when they are hidden. Moves from reflex actions to goal-directed activity.
Preoperational	2-7 years	Gradual language development and ability to think in symbolic form. Able to think operations through logically in one direction. Has difficulties seeing another person's point of view.
Concrete operational	7-11 years	Able to solve concrete problems in logical fashion. Understands laws of conservation and is able to classify and seriate. Understands reversibility.
Formal operational	11-15 years	Able to solve abstract problems in logical fashion. Thinking becomes more scientific. Develops concerns about social issues, identity

Source: From Becker, (1986), *Applied Psychology for Teachers, A Behavioral Cognitive Approach*, p.322.

2.1.3 Educational Implications of Piagetian Theory

Piaget's theory has inspired major curriculum reforms, and it continues to have an important influence on educational practice today. Among Piaget's major contributions to education are the ideas that (a) knowledge must be actively constructed by the child; (b) teachers should help children learn how to learn; (c) learning activities should be matched to the child's level of conceptual development; and (d) peer interactions play an important role in the child's cognitive development. Piaget's theory also emphasizes the role of teachers in the learning process as organizers, collaborators, stimulators, and guides. Piaget contended that cognitive development could not be taught, although research evidence shows that it can be accelerated (Zimmerman & Whitehurst, 1979, cited in Schunk, 2004). The theory and research suggest some implications for instruction. They are:

- Understand cognitive development,
- Keep students active,
- Create incongruity, and
- Provide social interaction.

1. Understand Cognitive Development

Teachers will benefit when they understand at what levels their students are functioning. All students in a class should not be expected to be operating at the same level. The teachers should try to ascertain levels and gear their teaching accordingly. They should also design learning experiences that are developmentally appropriate for the students. A developmentally appropriate activity is one that challenges a student's thinking, but that is not so difficult that the student is likely to fail. Students who seem to be in a stage transition may benefit from teaching at the next higher level, because the conflict will not be too great for them.

2. Keep Students Active

Piaget decried teachers actively teaching while students remained positive. Children need rich environments that allow for active exploration and hands-on activities. This arrangement facilitates active construction of knowledge.

3. Create Incongruity

Development occurs only when environmental inputs do not match students' schemata. Ideally material should not be readily assimilated but not too difficult to preclude accommodation. Incongruity also can be created by allowing students to solve problems and arrive at wrong answers. Nothing in Piaget's theory says that children always have to succeed; the teacher feedback indicating incorrect answers can promote disequilibrium.

4. Provide Social Interaction

Although Piaget's theory contends that development can proceed without social interaction, the social environment is nevertheless a key source for cognitive development. Teachers must design some activities that provide social interaction.

Learning that others have different points of view can help make children less egocentric. Also social interactions help older students become more reflective about their thinking.

2.1.4 Vygotsky's Cognitive Development Theory

Lev Vygotsky, a Russian psychologist, believed that cognitive development involves the internalization of functions that first occur on a social plane. Internalization refers to the process of constructing an internal representation of external physical actions or mental operations.

The child's culture shapes cognitive development by determining what and how the child will learn about the world. A major factor in that learning is language. Language provides not only a means for expressing ideas and asking questions but also the categories and concepts for thinking. Vygotsky identified three different stages in children's use of language: social, egocentric, and inner speech. In social speech, language is primarily used for communication. When children enter egocentric speech, they regulate their behavior and thinking by talking aloud to themselves as they work on various tasks. The last stage of speech development, inner speech, causes children to internalize egocentric speech. Language is used internally to guide their thinking and behavior. At this stage, children can think about problem solutions and action sequences by manipulating language "in their heads".

The zone of proximal development is one of the most important contributions of Vygotsky's theory to psychology and education. According to Vygotsky, learners have two different levels of development: the level of actual development and the level of potential development. The **level of actual development** defines an individual's current intellectual functioning and the ability to learn particular things on one's own. The **level of potential development** is defined as the level an individual can function at or achieve with the assistance of other people, such as a teacher, parent, or more advanced peer. The zone between the learner's actual level of development and the level of potential development was labeled by Vygotsky as the *zone of proximal development (*Arends, 2007).

2.1.5 Educational Implications of Vygotskian Theory

Vygotsky's theoretical ideas have implications for both instruction and assessment. The zone of proximal development provides a mechanism for providing strategy and skill learning. Teaching within the zone of proximal development can be conceptualized as a tutorial or as an opportunity for collaborative problem solving.

Tutoring within the Zone of Proximal Development

In a tutorial approach, learners interact with more skilled peers or adults to perform a task that those learners cannot perform independently. The adults or more skilled peers in these situations guide or support the performance of the learners with the goal of helping them internalize important skills or strategies. The guidance provided by more skilled learners is often referred to as scaffolding.

Scaffolding usually follows a three-step sequence. At first, the adults or more skilled learners assume most of the responsibility for completing the task. Second, the learner and the adult or peer guide share responsibility for task completion. The guide gradually relinquishes control to the learner as the learners' skills increase. Finally, the learner takes full responsibility for completing the task. This final step represents a transition from socially supported performance to independent performance.

Collaborative Problem Solving and the Zone of Proximal Development

Collaborative problem solving is a second way to conceptualize skill and strategy learning within the zone of proximal development. In this case, the idea of scaffolding of a more skilled learner is replaced by the ideas of two learners collaborating together to accomplish a goal (Well, 1999, cited in Fetsco & McClure, 2005). Through their interactions, they help each other develop new understandings or skills. This type of interaction is referred to as mutual or collective scaffolding.

According to Sunita (2012), the similarities and differences between Piaget's and Vygotsky's cognitive development are described as follows:

2.1.6 Similarities between Piaget’s and Vygotsky’s Cognitive Development Theory

- Both are significant contributors to the cognitive development component of psychology.
- Both are believed that the margins of cognitive growth are instituted by societal influences.
- Both are focused on the point that parents and teachers enable themselves to better cater to the unique needs of each child by understanding the progression of cognitive development.
- Both of them are believed that the manner by which children learn and mentally grow plays a vital role in their learning process and abilities.

The differences between Piaget's and Vygotsky's cognitive development theory are presented in Table 2.2.

Table 2.2 Differences between Piaget's and Vygotsky's Cognitive Development Theory

Materials	Piaget's Theory	Vygotsky's Theory
Theory	Natural line of development	Cultural line of development
Learning is	Solitary	Social
Child's learning process is	Independent	Dependent
Basic source of learning	Child himself	Zone of proximal development
Stages of development & basic concerns: Infancy (0-2 years) Early childhood (2-7 years) Middle childhood (7-11 years) Adolescence (12-19 years) Adulthood	 Sensorimotor stage Pre-operational stage Concrete operational stage Formal operational stage Formal operational stage	 Affiliation Play Learning Peer Work
Child is active	Child actively organizes cognitive schemas to maintain equilibrium.	Child active in providing feedback to the parent and instructor.
Role of language	Thought drives language.	Language drives thought.
Language plays	A plain milestone in cognitive development.	An important role in cognitive development.
Environment	Did not believe in the significance of inputs that can be acquired from the environment.	Kids do acknowledge the inputs from their environment.
Development	Same or universal.	Variable due to cultural differences.

Source: From Lokavishkar International E-Journal, ISSN 2277-727X, Vol-1, Issue-II, Apr-May-June 2012

The theories of Jean Piaget and Lev Vygotsky are reflected today in constructivism.

2.2 Constructivism

Constructivism is an educational theory that emphasizes hands-on, activity-based teaching and learning, and focuses on the personalized way a learner internalizes, shapes, or transforms information. Learning occurs through the construction of new, personalized understanding that results from the emergence of new cognitive structures. Students are active learners who should be given opportunities to "construct" their own frames of thought. Teaching techniques should include a variety of different learning activities during which students are free to infer and discover their own answers to important questions. Teachers need to spend time creating these learning situations.

The constructivist revolution has deep roots in the history of education. It draws heavily on the work of Piaget and Vygotsky. Both of them emphasized that cognitive change takes place only when previous conceptions go through a process of disequilibration in light of new information. They also emphasized the social nature of learning, and suggested the use of mixed-ability learning groups to promote conceptual change.

Modern constructivist thought draws most heavily on Vygotsky's theories, which have been used to support classroom instructional methods that emphasize cooperative learning, project-based learning, and discovery.

Four key principles derived from Vygotsky's ideas have played an important role. First is his emphasis on the social nature of learning (Hickey, 1997, cited in Slavin, 2003). Children learn, he proposed, through joint interactions with adults and more capable peers. Vygotsky noted that successful problem solvers talk themselves through difficult problems. In cooperative groups, children can hear this inner speech out loud and can learn how successful problem solvers are thinking through their approaches.

A second key concept is the idea that children learn best the concepts that are in their zone of proximal development. Children are working within their zone of proximal development when they are engaged in tasks that they could not do alone but can do with the assistance of peers or adults. When children are working together, each child is likely to have a peer performing on a given task at a slightly higher cognitive level, exactly within the child's zone of proximal development.

Another concept derived from Vygotsky's emphasis both on the social nature of learning and on the zone of proximal development is cognitive apprenticeship (Greeno, 1996, cited in Slavin, 2003). This term refers to the process by which a learner gradually acquires expertise through interaction with an expert, either an adult or an older or more advanced peer. Student teaching is a form of apprenticeship. Constructivist theorists suggest that teachers transfer this long-standing and highly effective model of teaching and learning to day-to-day activities in classrooms, both by engaging students in complex tasks and helping them through these tasks and by engaging students in heterogeneous, cooperative learning groups in which more advanced students help less advanced ones through complex tasks.

Finally, Vygotsky's emphasis on scaffolding, or mediated learning (Kozulin, 1995, cited in Slavin, 2003), is important in modern constructivist thought. Current interpretations of Vygotsky's ideas emphasizes the idea that students should be given complex, difficult, realistic tasks and then be given enough help to achieve these tasks. This principle is used to support the classroom use of projects, simulations, explorations in the community, writing for real audiences, and other authentic tasks. The term *situated learning* is used to describe learning that takes place in real-life, authentic tasks (Anderson, 2000, cited in Slavin, 2003).

A constructivist view of learning perceives children as intellectually active learners already holding ideas or schema which they use to make sense of their everyday experiences. Learning in classrooms involves the extension, elaboration or modification of their schemata. This process is one by which learners actively make sense of the world by constructing meanings. Learning is optimised in settings where social interaction, particularly between a learner and more knowledgeable others, is encouraged, and where co-operatively achieved success is a major aim. The medium for this success is talk, which is now widely accepted as a means of promoting pupils' understandings and of evaluating their progress (Moon, 1996).

2.2.1 Constructivist Learning Environments

Constructivist teaching is based on the belief that students should be actively involved in a process of meaning and knowledge construction as opposed to passively receiving information. It fosters critical thinking and creates active and motivated learners. Students are intrinsically motivated. They enjoy being in the classroom and participating in the learning activities being carried out. Teachers in a constructivist classroom are flexible and create ongoing experiences and lessons negotiated with groups of students and individual students. The environment is democratic, the teacher serves as a facilitator/ consultant, and lesson activities are interactive and student-centered. The goal of the teacher is to produce a democratic classroom environment that provides meaningful experiences.

Constructivists focus on the design of instructional environments that allow students to construct understandings. Effectively designed constructivist learning environments encourage students to engage in the active process of developing meaning through authentic learning experiences and interactions with others.

According to Jonassen (1999, cited in Fetsco & McClure, 2005), the constructivist learning environments have the following major components:

- A problem, case, issue or project that guides and structures the learning,
- Information resources or information banks to provide needed background information,
- Supporting tools, often in the form of technology applications, that include cognitive tools to support students' learning and problem solving, and conversation and collaboration tools to facilitate group problem solving and interactions, and
- Social/contextual support to provide training and environmental support needed by teachers and students.

According to Schunk (2004), some common features of constructivist instructional methods are described as follows:

- One is that the teacher is always the center of the instruction. Rather, environments are designed so that students have an active role in learning-mentally, physically, socially, and emotionally.
- Another common feature is diverse instructional formats-small groups, activity centers, peer collaboration, reciprocal teaching, cooperative learning, scaffolding and apprenticeships. Students are expected to take responsibility for their learning and contribute to the instruction and conservations.
- A third common feature is that learning tasks involve real-world problems rather than the artificial ones found in textbooks.
- Fourth, the environment should provide multiple representations of content. Assignments may require students to discuss material, read books, search the Web, make graphs and charts, develop a power point demonstration, and so forth. Such planning is difficult; it is much easier to design a lesson and present it to the class as a whole.

- In a constructivist environment, the teacher designs multiple activities for students to engage in and ensures that each student is exposed to different activities.

Constructivism does not absolve the teacher of responsibility. In some ways, it places greater demands on the teacher. Even in situations in which students work largely on their own without direct teacher intervention, the teacher must ensure that students are properly prepared with the skills they will need and that necessary materials are available.

Shifting Teacher and Student Roles

Shared ownership and responsibility for learning that occurs between teachers and students is a cornerstone of learner-centered practices. Current practices often necessitate a shift from traditional roles. According to Vatterott (1995, cited in McCombs, 1997), teachers no longer deliver the curriculum but mediate it in three ways. (1) Teachers design active learning tasks in which students learn by doing; there are opportunities for choice, autonomy, integration of content from more than one subject, application of content knowledge, and demonstrations of creativity and personal expression in student projects and products. (2) Teachers design assessments, ideally in partnership with students, as exhibitions or performances that encourage students to produce knowledge, create products, or engage in personal reflections. (3) Teachers direct time and energy away from content presentation or paper grading and toward the development of activities that focus students on their learning and how they will articulate or demonstrate that learning. Teachers also develop options for structuring and individualizing learning that is based on learning styles or multiple intelligences. Students' roles become more active–they construct their own knowledge, make their own meaning, and participate in the evaluation of their own meaning–leading to enhanced motivation and academic achievement. A change in the teacher-student relationship becomes more collaborative, students have more voice, and there is an underlying trust and respect.

The Role of Learner-centered Teachers

The learner-centered teachers

- Acknowledge and attend to students' uniqueness by taking into account and accommodating practices to students' states of mind, learning rates and styles, developmental stages, abilities, talents, sense of self, and academic and non academic needs.
- Know that learning is a constructive process and thus try to ensure that what students are asked to learn is relevant and meaningful, and also try to provide

learning experiences in which students are actively engaged in creating their own knowledge and connecting it to what they already know and have experienced.

- Create a positive climate by taking the time to talk with their students on a personal basis, getting to know them well, creating a comfortable and stimulating environment for them, and providing them with support, appreciation. Acknowledgment and respect come from an assumption that all their students, at their core, want to learn and want to do well, and have an intrinsic interest in mastering their world and relate to each student's core rather than trying to "fix" or ameliorate a deficiency.

Involving Students in the Learning Process

In order to motivate students to stay in school, four student opportunities that create a positive motivational context should be given. They are (1) the opportunity to *demonstrate competence and success*, (2) the opportunity to *become curious about and develop a desire for a deep understanding of new subject matter*, (3) the opportunity to *exhibit self-expression and originality in learning activities*, and (4) the opportunity to *feel connected to and involved in relationships with others in the school environment*.

The comparison of conventional and learner-centered school level characteristics is presented in Table 2.3.

Table 2.3 Comparison of Conventional and Learner-centered School Level Characteristics

Non-learner-centered Focus	Learner-centered Focus
Relationships are hierarchical, blaming, controlling.	**Relationships** are caring and promote positive expectations and participation.
Curriculum is fragmented, non experiential, limited, and exclusive of multiple perspectives.	**Curriculum** is thematic, experiential, challenging, comprehensive, and inclusive of multiple perspectives.
Instruction focuses on a narrow range of learning styles, builds from perceptions of student deficits, and is authoritarian.	**Instruction** focuses on a broad range of learning styles, builds from perceptions of student strengths, interest, and experiences, and is participatory and facilitative.
Grouping is tracked by perceptions of ability; promotes individual competition	**Grouping** is not tracked by perceptions of ability; promotes cooperation, shared

and a sense of alienation.	responsibility, and a sense of belonging.
Evaluation focuses on a limited range of intelligences, utilizes only standardized tests, and assumes only one correct answer.	**Evaluation** focuses on multiple intelligences, utilizes authentic assessments, and fosters self-reflection.

Source: From Berliner, (1995, cited in McCombs, 1997), *The Learner-centered Classroom and School*, p.115.

2.2.2 Implications of Constructivism in Teaching and Learning

Based on constructivism, some of the following important teaching-learning principles are:

- Teacher only plays the role as adviser, facilitator and planner while pupils will play the main role in the learning process.
- The most suitable method for teaching-learning is to use the cooperative and collaborative model.
- Pupil's knowledge and awareness are important factors to influence the process of cognitive development.
- Pupils must use their acquired knowledge to relate and apply to the learning of new knowledge.
- Intrinsic motivation is important for pupils to learn on their own initiative.
- The format and instruments of evaluation used for knowledge acquisition must be constructed by teacher and pupils together.
- Pupils are encouraged to use their critical and creative thinking skill to solve problems, and metacognitive skill, especially reflective thinking, to control, assess and make reflection on the result and achievement.

2.3 Behaviorism

Behaviorism is a psychological and educational theory that holds that one's behavior is determined by environment, not heredity. It focuses on the careful examination of environment, behaviors, and response. It also suggests that education can contribute significantly to the shaping of the individual, because the teacher can control the stimuli in a classroom and thereby influence student behavior. Behaviorists believe that the school environment must be highly organized and the curriculum based on behavioral objectives, and they hold that knowledge is best described as behaviors that are observable. They contend that empirical evidence is essential if students are to learn and that students must employ the scientific method to arrive at knowledge. The task of education is to develop learning environments that lead to desirable behaviors in students. Among the well-known, influential behaviorists in the formation of behaviorist learning theory are Pavlov, Thorndike and Skinner.

The behaviorist learning environment is characterized as follows:

- Prescribed knowledge is transmitted to learners according to a preplanned program.
- Specific activities are carried out to achieve the objectives.
- Learning is shaped by repetition and reinforcement as the learner responds to specific stimuli.
- The learner has no control of learning.
- The teacher is the authoritarian and center of the learning event.
- Evaluation is done individually at the end of the learning event to determine if objectives were met.
- Failure means the concept or learning content will be repeated until it is mastered.

2.3.1 Pavlov's Classical Conditioning

In a Russian laboratory in the 1920s, psychologist Ivan Petrovich Pavlov developed classical conditioning through the study of dogs (Woolfolk, 1990). From his perspective, learning begins with a stimulus response connection. Classical conditioning is the association of automatic response with new stimuli.

In his experiment, Pavlov began by sounding a tuning fork and recording the dog's response. As expected, there was no salivation. Then he fed the dog. The response was salivation. The food in this case was an **unconditioned stimulus** (**US**), since it brought forth an automatic response of salivation. The salivation was an **unconditioned response** (**UR**), again because it occurred automatically.

Using these three elements- the food, the salivation, and the tuning fork- Pavlov demonstrated that a dog could be conditioned to salivate after hearing the tuning fork. He did this by contiguous pairing of the sound with food. At the beginning of the experiment, he sounded the fork and then quickly fed the dog. After repeating this several times, the dog began to salivate after hearing the sound but before receiving the food. Then the tone had become a **conditioned stimulus** (**CS**) that could bring forth salivation by itself. The response of salivating after the tone, a **conditioned response** (**CR**), was very similar to the original response to the food.

2.3.2 Thorndike's Law of Learning Readiness

Edward Lee Thorndike followed the ideas and research of Pavlov, and developed law of readiness. Learning readiness refers to internal situations of an individual who is ready and capable to learn and acquire a certain new experience in learning (Sang, 2003).

Thorndike (1913) suggested the laws on learning readiness which can be summarized briefly as follows:

- When one is ready to carry out a certain action, and being successfully carried out, then one will be satisfied with the action.
- When one is ready to carry out a certain action, but fails to carry out successfully, then one will be disappointed.
- When one is not ready to carry out a certain action, but is forced to do it, then such action will cause one to feel sad and unhappy.

There are three types of learning readiness, namely *cognitive readiness, affective readiness and psychomotor readiness.*

- *Cognitive readiness* refers to an individual's mental readiness to carry out certain learning activity. It is related with the stages of intellectual development in thinking, reasoning, analyzing, synthesizing and evaluating.
- *Affective readiness* refers to an individual's attitude, desire, spirit, diligence, feeling and interest to carry out a certain learning activity.
- *Psychomotor readiness* refers to an individual's potential or physical maturity when he is ready to execute a certain physical action in a new learning process. An individual is said to possess psychomotor readiness if his body has reached the maturity stage in accordance to the required physical training.

Learning readiness is an important factor to guide pupils to carry out smooth, pleasant and effective learning activities. Therefore, teachers ought to understand and make use of their pupils' learning readiness to plan and implement suitable teaching-learning activities according to their stages of potential development.

2.3.3 Skinner's Operant Conditioning

Harvard psychologist B. F. Skinner, who built on and expanded Thorndike's work, was American's leading proponent of behaviorism throughout much of the 20^{th} century (Passer, 2007). Skinner coined the term *operant behavior*, meaning that an organism *operates* on its environment in some way. Operant conditioning is *a type of learning in which voluntary behavior is strengthened or weakened by consequences or antecedents* (Woolfolk, 1990). Skinner designed a **Skinner box**, *a special chamber used to study operant conditioning experimentally*. A lever on one wall is positioned above a small cup. When the lever is depressed, a food pellet automatically drops into the cup. A hungry rat is put into the chamber and, as it moves about, it accidentally presses the lever. A food pellet clinks into the cup, and the rat eats it.

Skinner's analysis of operant behavior involves three kinds of events that form a three-part contingency: (1) *antecedents,* which are stimuli that are present before a behavior occurs, (2) *behaviors* that the organism emits, and (3) *consequences* that follow the behaviors.

In activity-based learning, motivation is essential for the students to learn something.

2.4. Motivation

Motivation is defined as the processes that stimulate children's behavior or arouse them to take action. It is what makes them act the way they do. Pintrich (2003, cited in Arends, 2007) has observed that *motivation* comes from the Latin verb *movere* and refers to "what gets individuals moving" towards particular activities and tasks.

Motivation Characteristics

The characteristics of motivation are as follows:

- Its existence is due to the human physiological or psychological need.
- It is not inherited and does not exist naturally.
- It is an incentive to achieve a certain pre-determined goal.
- The level of motivation is directly proportional to the rate of desire. The stronger the desire to achieve a certain goal, the higher will be the level of motivation.

Psychologists make the distinction between two major types of motivation-intrinsic and extrinsic.

Intrinsic Motivation

Intrinsic motivation occurs when behavior is sparked internally by one's own interest or curiosity or just for the pure enjoyment of an experience. Intrinsic motivators are inherent in the instruction. Lepper and his associates (1985, cited in Alessi, 2001) suggest several techniques to enhance intrinsic motivation:

- Use game techniques,

- Use embellishments (such as visual techniques) to increase learner intensity of work and attention and to encourage deeper cognitive processing,
- Use exploratory environments,
- Give the learner personal control,
- Challenge the learner,
- Arouse the learner's curiosity, and
- Give encouragement, even when errors are made.

Teachers should know that students are likely to be motivated to learn when they have interesting tasks, expectations that they can be successful, and appropriate support for learning, and they should know how to construct these conditions. Research demonstrates that children are motivated to learn when they have confidence in their abilities, and when they have a good relationship with the teacher.

Intrinsic motivation for learning derives from the fact that humans typically want to understand the world, have control over their lives, and be self-directed. Learners are intrinsically motivated when they perceive themselves as the cause of their own behavior. Motivation theorists offer evidence that human beings are naturally diposed to develop skills and engage in learning-related activities.

To promote intrinsic motivation, teachers need to learn how to create academic environments in which students perceive themselves as being competent and having a measure of self-control, and they need to use scaffolding strategies to help their students overcome the difficulties or obstacles they face.

Extrinsic Motivation

Extrinsic motivation is characterized by individuals working for rewards that are external to the activity (Arends, 2007). It originates outside the individual and is concerned with external, environmental factors that help shape students' behaviors. It also arises from an external reward (Alderman, 1999, cited in Fetsco & McClure, 2005). Learners become extrinsically motivated when they reorganize a relationship between their actions and some external rewards. External rewards may include grades or praise from parents, the teacher, or classmates. These rewards are frequently public and under the control of others.

2.5 Bloom's Taxonomy of Cognitive Development

One of the best known systems for classifying questions according to cognitive complexity is the taxonomy of objectives in the cognitive domain. Bloom et al. (1956, cited in Jacobsen, Eggen, Kauchak, & Dulaney, 1985) identified six levels within the cognitive domain, from the simple recall or recognition of facts, as the lowest level, through increasingly more complex and abstract mental levels, to the highest order which is classified as evaluation. Bloom's taxonomy in theory helps teachers better prepare objectives and, from there, derive appropriate measures of learned capability and higher order thinking skills.

According to Bloom (1956), the cognitive domain consists of the following six major levels.

Level 1. Knowledge is defined as the remembering of previously learned material. This may involve the recall of a wide range material, from specific facts to complete theories.

Objectives: Know common terms, specific facts, methods, procedures, basic concepts, principles.

Level 2. Comprehension is defined as the ability to grasp the meaning of material. This may be shown by translating material from one form to another (words to numbers), by interpreting material (explaining or summarizing), and by estimating future trends (predicting consequences or effects).

Objectives: Understand facts and principles. Interpret verbal material, charts, and graphs. Translate verbal material to chemical formulas. Estimate future consequences implied by data. Justify method and procedures.

Level 3. Application refers to the ability to use learned material in new and concrete situations. This may include the application of such things as rules, methods, concepts, principles, laws, and theories.

Objectives: Apply concepts and principles to new situations. Apply laws and theories to practical situations. Solve chemical problems. Construct charts and graphs.

Level 4. Analysis refers to the ability to break down material into its component parts so that its organizational structure may be understood. This may include the identification of the parts, analysis of the relationships between parts, and recognition of the organizational principles involved.

Objectives: Recognize unstated assumptions and logical fallacies in reasoning. Distinguish between facts and inferences. Evaluate the relevancy of data. Analyze the organizational structure of a work.

Level 5. Synthesis refers to the ability to put parts together to form a new whole. This may involve the production of a unique communication (theme or speech), a plan of operations (research proposal), or a set of abstract relations (scheme for classifying information).

Objectives: Write a well-organized theme or give a well-organized speech. Propose a plan or create a new work or writing, music, art. Integrate learning from different areas into a plan to solve new problems. Formulate or develop new schemes for classifying.

Level 6. Evaluation is concerned with the ability to judge the value of material (statement, novel, poem, research report) for a given purpose. The judgments are to be based on definite criteria. These may be internal criteria (organization) or external criteria (relevance to the purpose), and the student may determine the criteria or be given them.

Objectives: Judge the logical consistency, the adequacy of conclusions, the value of a work by use of internal criteria, the value of a work by use of external standards.

2.6 Learning Activities

Learning activities are experiences designed to involve students in thinking about and using subject matter. Specific facts, generalizations and concepts do not encourage students to think, do not develop social and academic skills. These objectives are achieved primarily by the ways in which the basic content is translated into learnable tasks for the students in the classroom.

The emphasis of a learning activity is what the students do, not the teacher. The most appropriate type of learning activity depends not only on the intellectual and emotional development of the students involved, but also on the nature of the subject matter and the objectives that the teacher and the students want to attain.

2.6.1 Categories of Learning Activities

There are four categories of learning activities.

1. **Intake activities –** These activities are essential for students since they must have information to work with or think about before they can be expected to engage in an intelligent action.
2. **Organizational activities –** Such activities help students to organize the material to which they have been imposed.
3. **Demonstrative activities –** These activities help students to demonstrate what they have learned, to display the skills they possess and to demonstrate how well they can think.
4. **Expressive activities –** Such activities encourage students to express themselves by creating or producing an original product.

In too many classrooms, students are engaged for the most part in the same kinds of activities everyday they listen to teachers talk, they read and write. These kinds of activities are important. But different students learn in different ways. All four types of activities are essential if learning is to take place (Department of Methodology, 2013).

2.6.2 Necessary Skills for the Learners in Activities

If students are to engage successfully in learning activities, they will need to master a variety of skills that will help them learn. Such skills fall into three categories– **thinking skills, academic skills, and social skills**.

1. **Academic skills** include:

Reading	Books, articles, magazines, newspapers and other printed matter
Viewing	Films, pictures, transparencies, and the natural environment
Listening	To records, guest speakers, teachers, parents, and peers
Outlining	Of information obtained from printed, oral, or visual sources
Note-Taking	Using study questions, or upon listening to resource people
Caption Writing	Concise, accurate descriptions for bulletin boards or other classroom or report displays
Making Charts	Organizing information in various categories under different headings
Diagramming	Making a simple line drawing of an idea
Asking Relevant Questions	Of guest speakers and other sources, recognizing that different questions serve different purposes

2. **Social skills** include:

Planning with Others	Dividing the tasks involved in preparing a group-written report
Participating in Research Projects	Working in small groups of two or three to investigate a particular topic
Responding Courteously to the Questions of Others	Through learning to listen to what others are asking and then to respond appropriately

Leading Group Discussions	Through learning how to ask appropriate questions, how to encourage others to speak, and how to clarify others' responses
Acting Responsibly	Through estimating what the consequences of a given action may be and taking responsibility for those actions which one initiates
Helping Others	Through providing assistance when one has information which will make it easier for another to succeed in a given task

3. **Thinking skills** include:

Observing: It is a prerequisite to all intellectual operations that involve thinking. Students must be brought into contact with data before they can do anything with it. The teacher should provide opportunities for students to read, view, taste, hear, feel, smell, touch, and participate. The teacher makes the students become involved in so many kinds of experiences as possible.

Describing: Once students have been motivated to engage in experience, they must be encouraged to describe the characteristics of that which they have observed. The task of the teacher is to ask them to describe their observations. Care must be taken to ensure that students report their own, rather than the teacher's perceptions.

Comparing and contrasting: It is an important part of thinking. Students cannot understand objects, ideas, events, etc. clearly unless they can compare and contrast these phenomena in terms of similarities and differences. The teacher can help students to compare and contrast by asking them to study similar aspects of previously unrelated content, and then to ask identical questions about this content.

Developing concepts: Students form concepts when they begin to sort different objects, ideas, events, etc. they have observed or identified into a meaningful set of categories. The task of the teacher is to get the students to respond to questions which require them to identify the common characteristics of the items in a group, to label the groups they have formed, to subsume additional items that they have listed under those labels and to recombine items to form new groups.

Differentiating and defining: Students determine what attributes or characteristics they need to look for in order to decide whether particular examples are or are not instances of a concept. To broaden and deepen a student's understanding of a concept, examples which contain new attributes not contained in the original definition need to be presented. Students should be asked to compare these new examples with the examples they already know.

Generalizing: Students suggest a relationship among several concepts. For making warranted suggestions, they must look at two or more different samples of content, they must explain the data they have obtained and they must then offer a generalization. Teachers should encourage them to generalize through carefully thought out and sequenced questions.

Predicting and explaining: In predicting students apply generalization previously formed. In explaining they suggest reasons for various occurrences. Students are asked to make inferences based on their application of an idea they have previously formed as to what might happen in a new situation. They are asked to explain why they think this would happen.

Hypothesizing: A hypothesis is a prediction offered in order to provide a basis for further investigation. Hypothesizing is a key ingredient in the development of insights. It is central in the process of reflective thinking. This strategy is used to get students started in investigating a problem in which they are interested.

2.7 Activity-based Learning

Activity-based learning is a teaching method used by a teacher for students to learn something by doing. In an activity-based approach, the students are active, enquiring and learn by testing out their hypotheses about the world (Superfine, 1999). By learning chemistry through investigations, creativity or problem solving, it is hoped that the students are more likely to see the purpose of their learning. The principle behind the activity-based approach is that the students are "doers" and learn chemistry primarily because they need it, have encountered and used it in a realistic situation. Activity-based learning recognizes that the students are tactile and use all their senses. It is primarily driven by the intrinsic interest of the activity for the students. The role of a teacher may be a facilitator or a decision maker.

An activity-based learning curriculum

- is student-centered and learning-centered,
- is task based learning,
- gives enjoyment and fun,
- uses authentic tasks and situations,
- can be linked to a particular topic,

- focuses on meaning and form,
- acquires knowledge and skills, and
- reflects the world around them.

Activity-based learning focuses on the three "Cs" of Curiosity, Creativity and Collaboration.

Curiosity: Students whose interest is engaged by a task are capable of longer periods of attention than is usually recognized. The students who want to find out how something can be made to work or who are trying to make something on their own are driven by a sense of curiosity. According to the great psychologists, Piaget, Vygotsky and Bruner, the students are instinctively programmed to learn. They are in a continuous cycle of discovery, forming hypotheses, testing those hypotheses and discovering concepts and skills. They are driven by their insatiable curiosity.

Creativity: Creativity is based on something that virtually everyone is born with: imagination. The students like to make things during the activities. Their creativity is more wide-ranging than a traditional reading/writing lesson allows for. The pride with which they view their achievements may be worth it. According to Trilling (2009), there is no age limit to creative work. Creativity can be nurtured by learning environments that fosters questioning, patience, openness to fresh ideas, high levels of trust, and learning from mistakes and failures.

Collaboration: Activity-based learning can cater for the individual and the group. Because many potential activities are practical "doing" tasks, they enable the students to gain self-esteem. Tasks can be more easily adapted to suit different levels of ability. Therefore, the individual with special learning needs can be supported or "scaffolded". At the same time, the tasks can be performed as group activities and are often deliberately collaborative.

Collaborative learning is based on social constructivism, so collaborative teaching methods should take into account the social aspects of learning. One way of fostering a collaborative learning environment is working in small groups. According to Kagan (1988, cited in Moon, 1996), group size has a marked impart on the opportunity for, and the nature of, students' interactions. Since the number of students in a group will determine the number of lines of communication, teams of four members are ideal.

Perhaps one of the most important concepts about group work is that the students will need to learn how to work effectively in groups. To be a successful group work, Lonning (1993, cited in Gallagher, 2007) suggests five areas of positive collaborative learning behaviors. They are positive independence, face-to-face interaction, individual accountability, interpersonal and small-group skills, and feedback for group members. Finally, working in small groups makes shared learning.

The teachers must be able to contextualize their teaching-learning process to help the students make connections between what they are learning and how that knowledge will be used.

2.8 Teaching Contextually

There are five contextual teaching strategies used by outstanding teachers: relating (R), experiencing (E), applying (A), cooperating (C) and transferring (T). REACT is an easily remembered acronym and focuses on teaching and learning in context– a fundamental principle of constructivism (Crawford, 2001).

Relating: Relating is the most powerful contextual teaching strategy. It is also at the heart of constructivism. Relating is *learning in the context of students' life experiences or preexisting knowledge*. Teachers use relating when they link a new concept to something completely familiar to students. When the link is successful, students gain almost instant insight. This reaction is called "felt meaning" because of the "aha!" sensation that often accompanies the insight. Felt meaning can be momentous, as when a student first sees the solution to a problem that he or she has spent significant time and effort in solving. Teachers are using relating when they both provide environments in which students activate memories or prior knowledge and recognize the relevance of the memories or knowledge. Learning is enhanced when teachers use relating, especially at the beginning of instruction with students' prior knowledge and beliefs as a starting point, and then adjust teaching in response to students' changing conceptions during instruction.

There are three primary sources to know or discover students' prior knowledge and beliefs.

- Experience – from the teacher's own experience with students of similar backgrounds or from the collective experience of the teacher and his or her colleagues
- Research – from documented evidence of students' commonly held ideas
- Probes – from carefully designed questions or tasks that reveal students' prior knowledge and beliefs

Experiencing: Experiencing is *learning by doing—through exploration, discovery, and invention*. It is the heart of contextual learning. Teachers can help students construct new knowledge with orchestrated, hands-on experiences that take place inside the classroom. In-class hands-on experiences can include the use of manipulatives, problem-solving activities, and laboratories. In contextual academic texts, laboratories are often based on actual workplace tasks. The aim is not to train students for specific jobs, but to allow them to experience activities that are directly related to real-life work.

To "learn from experience" is to make a backward and forward connection between what the students do to things and what they enjoy or suffer from things in consequence (Dewey, 1916). Students in experiential learning situations cooperate and learn from one another in a more semi-structured approach. Instruction is designed to engage students in direct experiences which are tied to real world problems and situations in which the teacher facilitates rather than directs student progress. Through the experiences, the students develop communication skills and self-confidence and gain and strengthen decision-making skills. The focus of experiential learning is placed on the process of learning and not the product of learning. It is in line with a Chinese proverb,
"*I hear and I forget, I see and I remember, I do and I understand*."

Applying: Applying means *learning by putting the concepts to use*. Obviously, students apply concepts when they are engaged in hands-on problem-solving activities and projects. Teachers also can motivate a need for understanding the concepts by assigning *realistic* and *relevant* exercises. These exercises both pose very realistic situations, and demonstrate the utility of academic concepts in some area of a person's life.

The realistic or authentic exercises can motivate students to learn academic concepts at a deeper level of understanding. The suggested classroom strategies include:

• *Focus on meaningful aspects of learning activities.* Teachers should stress how the academic tasks that are done in the classroom are relevant and 'authentic' in the real world.

• *Design tasks for novelty, variety, diversity, and interest.* Teachers should attempt to provide a wide variety of tasks for students to engage in and ensure that the tasks have some novel, interesting, or surprising features that will engage the students.

• *Design tasks that are challenging but reasonable in terms of students'capabilities.*
A task that is in-between, "challenging but reasonable," is one in which students can make legitimate progress while constructing new knowledge.

Relating and experiencing are strategies for developing insight, felt meaning, and understanding. These insights are empowering—they foster an attitude in students that "I *can* learn this." Applying is a contextual teaching and learning strategy that develops a deeper sense of meaning—a reason for learning. This strategy fosters a second attitude that "I *need* or *want* to learn this."

Cooperating: Cooperating is *learning in the context of sharing, responding and communicating with other learners*. In cooperating, students-led groups are used to complete exercises or hands-on activities. Students working in small groups can often handle the complex problems with little outside help.

Working with their peers in small groups, most students feel less self-conscious and can ask questions without feeling embarrassed. They also will more readily explain their understanding of concepts to others or recommend problem-solving approaches for the group. By listening to others in the group, students reevaluate and reformulate their own sense of understanding. They learn to value the opinions of others because sometimes a different strategy proves to be a better approach to the problem. When a group succeeds in reaching a common goal, student members of the group experience higher self-confidence and motivation than when students work alone. Many teachers assign student roles for the activities. Roles instill a sense of identity and responsibility and become very important as students realize that successful completion of an activity depends on every group member doing his or her job. Success also depends on other group processes—communication, observation, suggestion, discussion, analysis, and reflection.

The guidelines to help teachers avoid the negative conditions and create environments for students to learn concepts at a deeper level of understanding include:

• *Structuring positive interdependence within student learning groups.* Positive interdependence means that each student feels that he or she cannot succeed unless all the members of the group succeed. Teachers create positive interdependence by making sure students have common goals and rewards, making students depend on other students for resources, assigning a role to each student in a group, and ensuring that tasks are equally divided.

• *Having students* interact *while completing assignments and ensuring that the interactions are on-task.* Interactions include student-to-student help and encouragement, explanations of ideas and problem-solving strategies, and discussions of other ideas related to the assignment.

• *Holding all students individually accountable for completing assignments and not letting them rely overly on the work of others*. Two strategies for holding students accountable are giving an individual test to each student rather than allowing group work on tests and randomly selecting one student's work to represent the work of the group.

• *Having students learn to use interpersonal and small group skills*. These skills include leadership, decision making, trust building, communication, and conflict management.

• *Ensuring that learning groups discuss how well the group functions*. When students receive feedback on their participation in the group, they can reflect on their roles and, if needed, adjust and adapt their social skills to help the group meet its objectives.

Cooperative learning clearly places new demands on the teacher. The teacher must form effective groups, assign appropriate tasks, be keenly observant during group activities, diagnose problems quickly, and supply information or direction necessary to keep all groups moving forward. The teacher may be a lecturer, an observer, or a facilitator.

Transferring: Transferring is *using knowledge in a new context or novel situation—one that has not been covered in class.* Transfer is a key concept in education and learning theory because most formal education aspires to transfer. Usually the context of learning differs markedly from the ultimate contexts of application. Consequently, the ends of education are not achieved unless transfer occurs.

Students who learn with understanding can also learn to transfer knowledge. In a constructivist or contextual classroom, the teacher's role is expanded to include creating a variety of learning experiences with a focus on understanding rather than memorization. In addition to skill drill and word problems, the teachers assign experiential, hands-on activities and realistic problems through which students gain initial understanding and deepen their understanding of concepts.

Transfer is obviously a goal of learning (Hammond, 2005). It is inhibited when students learn by rote and go through mechanical routines to solve problems without thinking but is more likely to be supported when initial learning focuses on understanding of underlying principles, when cause-and-effect relationships and reasons are explicitly considered, and when principles of application are directly engaged.

According to Schunk (2004), there are different types of transfer.

Positive Transfer: Positive transfer occurs when prior learning facilitates subsequent learning.

Negative Transfer: Negative transfer means that prior learning interferes with subsequent learning.

Zero Transfer: Zero transfer means that one type of learning has no noticeable influence on subsequent learning.

Clark (1985, cited in Alessi, 2001) describes the difference between near and far transfer.

Near Transfer: Near transfer is applying the learned information or skills in a new environment that is very like the original one.

Far Transfer: Far transfer is being able to use learned knowledge or skills in very different environments.

2.9 Learners and Learning

Currently five general concepts that summarize the knowledge base on how people learn are:

- What learners already know influences their learning.
- Learners construct new knowledge.
- Knowledge is constructed through a process of change.
- New knowledge comes from experiences.
- Everyone is able to understand and do science (Horsley, 2010).

1. What learners already know influences their learning.

What students already know and believe influences what and how they learn. What learners know is an important foundation for their future learning. When consistent with conceptions that are currently accepted by students, this prior or informal knowledge is a strong base to build new understandings. Sometimes, however, learners' conceptions are inconsistent with accepted knowledge and are called alternative conceptions. Learning involves building on or modifying existing ideas. This understanding of how prior knowledge influences how learners interpret and interact with new ideas and information has had a profound influence on the design of learning experiences. Students' prior knowledge and alternative conceptions must be taken into account to support them to develop deeper understanding. To do so, teachers need skills for assessing and challenging students' ideas and connecting new knowledge to what students already know and believe.

Learning is also influenced by the learners' expectations, attitudes and beliefs about themselves and about learning, schooling and the community in which they live. When individuals are learning effectively, they are engaged in what they are doing and expect that it will make sense to them. They do not expect learning to be easy and instantaneous, but have confidence that understanding will come from persistence, interaction with ideas and natural phenomena, dialogue with peers and teachers, attention to other possible ideas, and a willingness to change their view on the basis of compelling new evidence.

2. Learners construct new knowledge.

Learning is a process through which learners construct their knowledge by modifying or revising existing ideas. This idea is based on the view of learning as a personal and active process through which the learner interacts with information and experiences and filters them through what they already know. Learning comes from thinking through and often struggling with problems and situations to arrive at new understandings. Learners interact in a very active sense with ideas and experiences. They need to develop conceptual understanding as well as procedural information and learn to apply and transfer knowledge of the content flexibly. Understanding concepts deeply helps learners better integrate their knowledge and know when ideas can be applied in different contexts. Developing conceptual understanding is more complex than memorizing a procedure and involves experience, metacognition, and developing and revising ideas over time.

3. Knowledge is constructed through a process of change.

Learners evolve from their current state of knowledge in four different ways: (1) when new ideas fit naturally with existing ideas and are added to them; (2) when learners create a new idea out of existing knowledge; (3) when new ideas extend and challenge existing knowledge; and (4) when learners see that new ideas are powerful but irreconcilable with existing knowledge, leading to the rejection of their existing knowledge. As students transform their thinking, they build on prior knowledge. This process of building on prior knowledge to understand more complex knowledge and develop more sophisticated ways of thinking is called a *learning progression*.

4. New knowledge comes from experiences.

Learning arises in different ways as learners inquire into natural phenomena, grapple with challenging problems, raise and address questions, interact with people and resources, and reflect on their thoughts and ideas. In support of using a diverse array of instructional activities, research shows that hands-on activities, analyses of preexisting data, and direct instruction support student learning of science. By including direct observation of and experience with phenomena, ideas and instructional materials, and input from the teachers and experts in the field, the teachers provide numerous experiential pathways towards learning for their students.

5. Everyone is able to understand and do science.

All students must be provided with opportunities and support to develop science literacy and the essential skills needed for productive life in the twenty-first century. Actually, all of them from very young ages come to school with conceptions about the world, are curious about phenomena, and can inquire into them and make meaning of them. When they have access to quality teaching and high expectations, they are able to meet standards for content learning, and are capable of learning. The flame of learning should be kept alive by challenging all students to learn these subjects that are most critical for the future. Educational equity and opportunity for learning are enhanced when teachers, students, and families hold high expectations for student learning.

2.10 Learning to Learn and Innovate

Trilling (2009) said that the first set of 21st century skills focused on critical learning skills and innovation:

- Critical thinking and problem solving (expert thinking),
- Communication and collaboration (complex communicating), and
- Creativity and innovation (applied imagination and invention).

(1) Critical Thinking and Problem Solving Skills

Students should be able to:

Reason effectively

- Use various types of reasoning as appropriate to the situation

Use systems thinking

- Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems

Make judgments and decisions

- Effectively analyze and evaluate evidence, arguments, claims and beliefs
- Analyze and evaluate major alternative points of view
- Synthesize and make connections between information and arguments
- Interpret information and draw conclusions based on the best analysis

- Reflect critically on learning experiences and processes

Solve problems

- Solve different kinds of non familiar problems in both conventional and innovative ways
- Identify and ask significant questions that clarify various points of view and lead to better solutions

(2) Communication and Collaboration Skills

Students should be able to:

Communicate clearly

- Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts
- Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions
- Use communication for a range of purposes
- Utilize multiple media and technologies, and know how to judge their effectiveness and assess their impact
- Communicate effectively in diverse environments

Collaborate with others

- Demonstrate ability to work effectively and respectfully with diverse teams
- Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal
- Assume shared responsibility for collaborative work, and value the individual contributions made by each team member

(3) Creativity and Innovation Skills

Students should be able to:

Think creatively

- Use a wide range of idea creation techniques
- Create novel, new and worthwhile ideas
- Elaborate, refine, analyze and evaluate their own ideas in order to improve and maximize creative efforts

Work creatively with others

- Develop, implement and communicate new ideas to others effectively
- Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work
- Demonstrate originality and inventiveness in work and understand the real world limits to adopting new ideas
- View failure as an opportunity to learn; understand that creativity and innovation is a long-term, cyclical process of small successes and frequent mistakes

Implement innovations

- Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur

The depth of knowledge a teacher has about chemistry influences the amount of planning necessary for his lessons.

2.11 The Early History of Chemistry

Chemistry has gained a secure position in the curricula of schools, technical colleges and universities (Newburg, 1971). The importance of the subject is recognized by all educationalists. A study of the development of chemistry itself and of its introduction into educational institutions reveals a steady advance to its present status.

The word chemistry is probably derived from the Egyptian word *chemeia*, meaning Egypt, the black land of the Nile. The Chinese and the Egyptians carried out simple operations of filtering, evaporation, distillation and sublimation.

The Greeks, notably Aristotle (384 - 322 B.C.) and Democritus, based their views of the structure of matter on pure reasoning, without confirmation by experiment. At the beginning of the seventh century the Arabs systematized the known facts. They also prepared dyes, glass, silver nitrate, hydrochloric acid, nitric acid, sulphuric acid and ammonium chloride. Further, they devised new types of apparatus and built libraries and laboratories. By conquering Spain they first carried the knowledge of chemistry into Europe. Much of their time was given to Alchemy. The alchemists were preoccupied in trying to discover the universal solvent, the elixir vitae and the philosopher's stone.

The name of Paracelsus (1493 - 1541) is connected with the period when chemicals were first used as medicines. The period of iatro-chemistry, or medical chemistry, was notable for improved methods of preparing and purifying chemicals for pharmaceutical uses. The foundation of scientific method was laid by Francis Bacon (1561 - 1626), who stressed the importance of accurate experiment and an orderly arrangement of facts and brought to the forefront the inductive method of reasoning as a guide to investigation.

A scientific method was developing and chemistry was put on a firmer basis. Robert Boyle (1627 - 1691) is considered to be the founder of modern chemistry. His papers on the structure of matter, combustion and the physical properties of gases are of prime importance. He did much to free chemistry from the early superstitious ideas which clung to it and contended that chemistry should be studied so that human knowledge could be increased.

The Makers in the history of chemistry are van Helmont, Stahl, Black, Cavendish, Priestley, Scheele, Lavoisier and Dalton. *Van Helmont* (1577 - 1644) was a practical chemist who first used the term gas. He prepared different gases by the action of acids on metals, by fermentation and by burning charcoal, and studied their properties. *Stahl* (1660 - 1734) was the originator of the phlogiston theory of combustion. Phlogiston was assumed to be present in substances which burnt and to be given off during burning. *Black* (1728 - 1799) was the great pioneer in quantitative chemistry. He was the first chemist to study the properties of carbon dioxide. *Cavendish* (1731 - 1810) investigated the properties of carbon dioxide and hydrogen, studied the composition of air and water, and improved methods of collecting gases. *Priestley* (1733 - 1804) prepared oxygen, nitrous oxide, nitric oxide, sulphur dioxide, hydrogen sulphide, ammonia, hydrogen chloride and silicon tetrafluoride. He improved the apparatus used to collect gases by displacement of liquids. *Scheele* (1742 - 1786) was essentially a chemist who worked in the laboratory, and discovered chlorine, hydrofluoric acid, ammonia and oxygen and hydrogen chloride. *Lavoisier* (1743 - 1794), a Frenchman and one of the most brilliant of all chemists, heated mercury in a known volume of air to form mercuric oxide. Then he verified the law of conservation of mass, and formulated the present theory of combustion: that breathing is slow oxidation, that burning is a rapid oxidation and that oxygen is necessary for breathing and burning. *Dalton* (1766 - 1844) formulated the basis of the atomic theory and thus gave a theoretical explanation to the laws of multiple proportions.

2.11.1 Chemistry and its Importance

Science is a holistic activity which involves observing, thinking and doing. To learn and understand science, students must not only study it, but also experience it. Chemistry is one of the different branches of science. According to Kask (1993), the study of chemistry is commonly divided into five major areas:

- The branch of chemistry that deals primarily with substances containing carbon is called **organic chemistry**.
- Non-carbon-containing substances are the major concern of **inorganic chemistry**.
- The branch of chemistry concerned with the methods and instruments for determining the composition of matter is called **analytical chemistry**.
- The laws of physics are applied to the investigation of the structure and changes of matter in the branch of chemistry called **physical chemistry**.
- The physical and chemical changes that occur in living organisms are the province of **biochemistry**.

Chemistry is often called the 'central science' because an understanding of chemistry is necessary to an understanding of the other sciences such as biology, physics, geology, materials science, the environmental sciences, etc (Ray, 2009). It has been 'central' in its utility, in the ubiquity of the products of chemistry in all facets of life, in all aspects of economic development. And for the future, chemists are uniquely qualified to contribute to the solution of many of the problems facing both developed and emerging nations, at different levels, with the issue of sustaining, environmentally benign economic growth.

Chemistry touches everyone's life everyday. There are man-made chemicals such as cleaning agents, medicines, computer chips, synthetic fabrics, plastic materials, food additives and energy sources. There are entire chemical fields such as pharmacology, nuclear chemistry, biochemistry, genetic engineering, geochemistry and cosmochemistry. Everyone is engulfed in a world of chemistry.

Chemistry is an expression of two of the most important human characteristics; the ability to be curious and the desire to be creative. Teaching of chemistry is different from teaching other conventional disciplines, as applied or practical aspect is equally important in chemistry teaching besides the theory. Consequently, teachers must help students to acquire knowledge of basic chemistry concepts and the application and relevance of these to their everyday lives.

2.11.2 The Benefits Derived from the Advance of Chemistry

According to Newbury (1971), the material benefits derived from the use and study of chemistry are:

- the contribution to improved health,
- the supply of foodstuffs,
- the increase in comfort, convenience and pleasure,
- the increased efficiency of industrial processes, and
- the reduction of dependence on local natural materials.

2.11.3 The Educational Advantages Derived from the Study of Chemistry

The chief educational advantages derived from studying chemistry are:

- Chemistry gives an essential background of knowledge for cultural development.
- Chemistry gives many opportunities to foster the scientific method and discipline as it trains the students to observe and think clearly and carefully.
- Chemistry stresses the need to appreciate the meaning of scientific life, spirit and endeavour.
- Chemistry acquaints the students with knowledge of chemical facts needed not only for professions but also for citizens to enable them to lead happy, well-balanced and useful lives.

2.11.4 A Successful Chemistry Teacher

The key to high quality chemical education is the chemistry teacher in a classroom (Unesco, 1984). It is in this setting that students become interested or lost interest in chemistry. They establish a base of concepts and skills that are dependable or unreliable. For these reasons the importance of the competent chemistry teacher cannot be overestimated. There are at least five qualities that a chemistry teacher will need for the future and the challenges associated with providing a chemical education for all. These include curiosity, competence, commitment, creativity and compassion. The first four are more familiar to the teachers than the last, yet the newly emerging sense of compassion, the humanization of science, is very important. It is this quality that brings science into harmony with the society and the culture that it impacts daily and in a very personal way.

Curiosity: Curiosity is the spirit of inquiry, the asking of question, and the desire to know.

Competence: Competence is the know-how, understanding of chemistry and the ability to teach it with enthusiasm and to bring the latest research results into the classroom in an effective way.

Creativity: Creativity is a special capacity within the teachers in varying degrees. It involves insight, intuition, the ability to make intellectual leaps, to see spatial relationships, to transfer knowledge to new situations, to think new thoughts, to develop ideas and to design and produce new instructional materials.

Commitment: Commitment means a sensing of the values in chemistry as a discipline and in the worth of a life spent working with young people to feel pride, satisfaction, dedication and achievement and to exude enthusiasm.

Compassion: Compassion is concerned with feelings, with concern for the individual and with the interface between science and social responsibility.

Characteristics of a successful chemistry teacher include enthusiasm for chemistry, love and understanding of the students and the challenge of developing future potential through education. He is up to date and well grounded in chemistry facts, theories and laboratory procedures. Moreover, he knows how to manage a laboratory, guide experimental work, follow safe procedures, use emergency care in case of accident and orchestrate changes of pace in the classroom. In order to motivate students and facilitate their learning, teachers must possess in their repertoire of skills a mix of mini-lectures and interaction modes through skilled questioning, facilitation of discussions and encouragement of problem-solving and then employ these judiciously.

2.11.5 Interaction between Teacher and Student in Chemistry

According to Ray (2009), effective teachers interact with students in a skillful manner by establishing a rapport with the class by:

- Creating a comfortable atmosphere in which learning is enjoyable and where individuality and creativity are encouraged,
- Being open to student questions by observing students' responses and sensing their confusions,
- Responding to their questions with respect and being courteous in dealing with questions that are irrelevant,
- Stimulating class participation and discussion, and
- Conveying enthusiasm for the subject by being attentive to students, moving away from the chalkboard, having eye contact with students to observe students'

expressions, using humour appropriate to the subject, and indicating a genuine interest in their contributions and concern for their learning.

All effective teachers have a planned pattern of instruction for every lesson.

2.12 Bloom's Evaluation Approach to Lesson Planning

Benjamin Bloom (1956) provides an evaluation approach to a lesson plan. Evaluation is a process of gathering information to make judgments and decisions about individuals (Collette, 1989). The lesson plan is a practical outline of a topic to be taught in a period. His approach is a new innovation in the field of education. It has revolutionized the teaching, learning and testing process and considers that education is the tricolor process. It has the following features (Singh, 2009):

(a) Formulating Educational Objectives,

(b) Creating Learning Experiences, and

(c) Evaluating the Change of Behaviors.

Bloom's evaluation approach is illustrated in Figure 2.1.

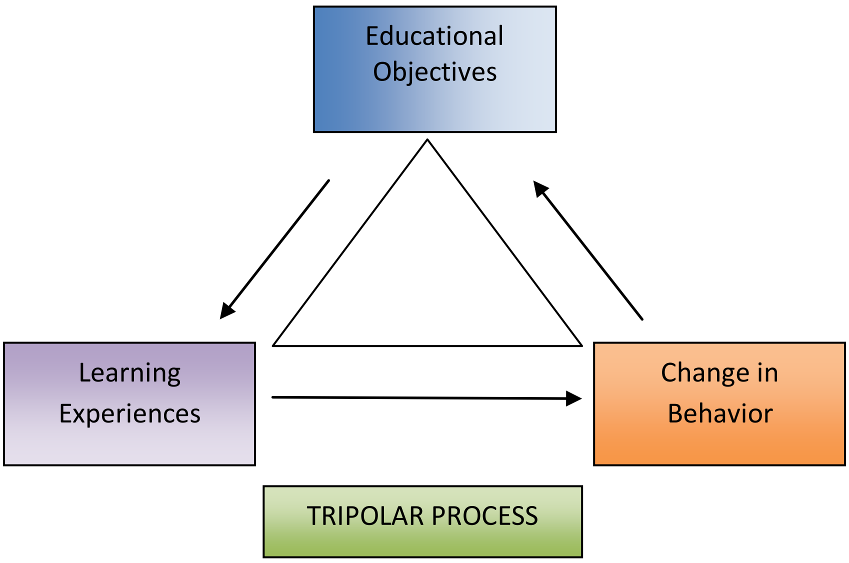

Figure 2.1 Learning Process of Bloom's Evaluation Approach

Source: From Singh, (2009), *Teaching Practice: Lesson Planning*, p.44.

2.13 The Inquiry-discovery Model

Inquiry learning provides opportunities for students to experience and acquire processes through which they can gather information about the world. This requires a high level of interaction among the students, the teacher, the area of study, available resources, and the learning environment. Moreover, in discovery learning, the students are encouraged to their own understandings or meanings. Experiments rather than teacher demonstrations are a part of discovery learning. The inquiry-discovery model is actually an integration of the *inquiry method and discovery method*. Although the concepts of inquiry method and discovery method are different, yet their approach, strategy, aim, principle and steps involved in carrying out their research activities are similar.

The *inquiry-discovery model* is based on the cognitive learning theories, especially from John Dewey and Bruner. As in the inquiry and discovery methods, this model covers activities such as planning, investigating, analyzing, and discovering. Through the process of inquiry-discovery, the students will understand better the concepts related to principle, law, generalization or formula rather than directly explain the meaning underlying these concepts.

Learning by means of this method needs skills such as making comparison and looking for similar characteristics to formulate a certain generalization. There are five steps in the learning process via the inquiry-discovery model (Sang, 2003). They are:

(a) Identify the research topic,

(b) Plan strategy for solving the problem,

(c) Collect related information,

(d) Study and analyze the information, and

(e) Derive generalization or conclusion.

An inquiry-discovery model is presented in Figure 2.2.

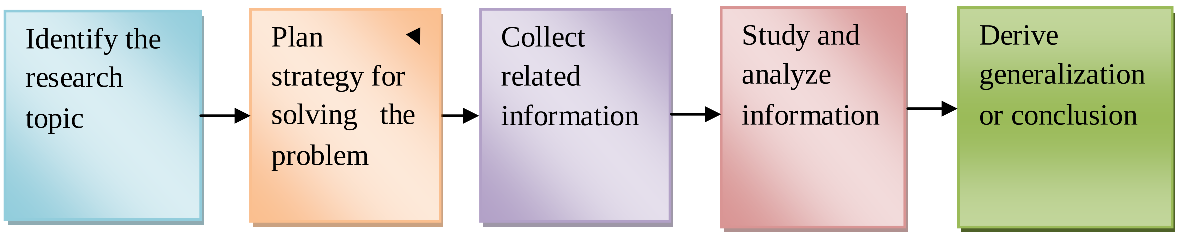

Figure 2.2 Learning Process via Inquiry-discovery Method

Source: From Sang, (2003), *An Education Course for K.P.L.I, Theme 2,* p.208.

2.14 Developing Activity-based Learning Performance Model

A model of teaching is a plan or pattern that can be used to shape curriculums, to design instructional materials and to guide instruction in the classroom and other settings (Joyce, 1980). A model represents the broadest level of instructional practices and presents a philosophical orientation to instruction.

Activity-based learning performance model is a guideline and should be used as checklist in planning for teaching-learning situations. This model is developed based on the first two models such as Bloom's evaluation approach and inquiry-discovery model with the aim to produce effective process of teaching-learning (see Figure 2.3).

The description of activity-based learning performance model is presented as follows:

(a) Statement of the Problem,

(b) Learning Experiences,

(c) Collection and Analysis of Information, and

(d) Generalization or Conclusion.

(a) Statement of the Problem

The problem determined by a teacher is introduced to students, but must be of sufficient significance to motivate students to be interested and curious. A problem is a "situation in which students are trying to reach some goal, and must find a means for getting there." For students to understand clearly, the teacher should tell his or her students about the objective of the problem. The objective is the end result of any activity. So, the problem must be defined in terms of specific objectives concerning the kind of information needed.

(b) Learning Experiences

After identifying the learning objective, the appropriate teaching strategies, teaching aids and tactics are selected for generating the environments which provide the learning experiences to the students. The learning experiences are directly related to the objectives of teaching. These learning experiences may be provided in or outside the school and in the classroom. A teacher organizes his or her activities to acquire the desirable objective among the students. The teaching activities are related to learning outcomes.

(c) Collection and Analysis of Information

After students had created learning experiences, they collect information by means of observing, measuring, carrying out experiment or finding reference. Then the collected information is noted down, tabulated, classified, analyzed and interpreted.

(d) Generalization or Conclusion

The last component of this model is to generalize and conclude the information. The generalization and conclusion are derived and recorded based on the findings of the analysis and interpretation.

Activity-based learning performance model is presented in Figure 2.3.

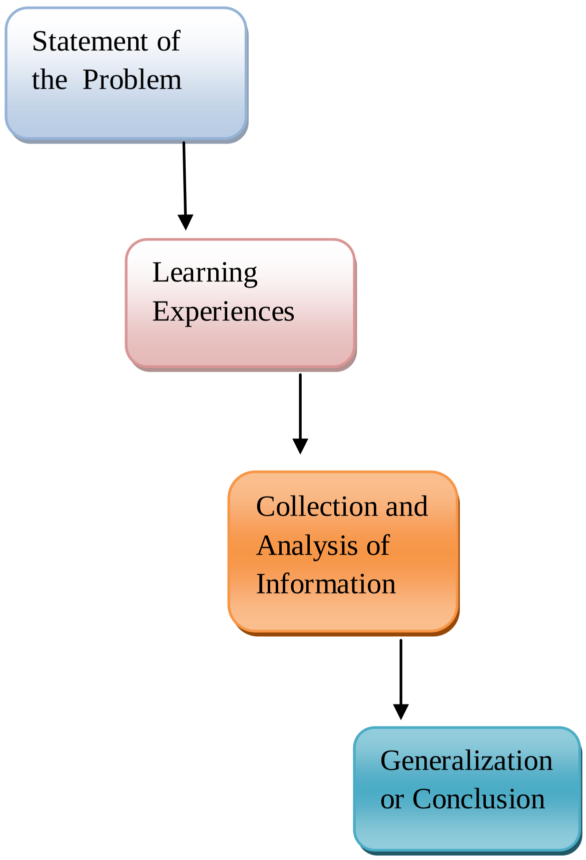

Figure 2.3 Activity-based Learning Performance Model

References

Alessi, S. M., & Trollip, S. R. (2001). *Multimedia for Learning: Methods and Development* (3rd ed.). Boston: A Pearson Education Company.

Arends, R. I. (2007). *Learning to Teach* (7th ed.). New York: Mc Graw-Hill.

Becker, W. C. (1986). *Applied Psychology for Teachers, A Behavioral Cognitive Approach*. USA: Science Research Associates, Inc.

Bloom, B. S. (1956). *Taxonomy of Educational Objectives: The Classification of Educational Goals*. New York: David Makay.

Collette, A. T., & Chiappetta, E. L. (1989). *Science Instruction in the Middle and Secondary Schools* (2nd ed.). Columbus: Merrill Publishing Company.

Crawford, M. L. (2001). *Teaching Contextually*. Retrieved October 16, 2013, from http://www.cord.org/uploadedfiles/Teaching%20Contextually%20%28Crawford%29.pdf

Department of Methodology. AY (2013-2014). *General Methodology*. *B.Ed Third Year, First Semester*. Yangon: Yangon Institute of Education.

Dewey, J. (1916). *Democracy and Education*. New York: Dover Publications, Inc.

Fetsco, T., & McClure, J. (2005). *Educational Psychology. An Integrated Approach to Classroom Decisions*. Boston: Pearson Education, Inc.

Gallagher, J. J. (2007). *Teaching Science for Understanding*: *A Practical Guide for Middle and High School Teachers*. New Jersey: Pearson Education, Inc.

Hammond, D. L., & Bransford, J. (2005). *Preparing Teachers for a Changing World*. San Francisco: John Wiley & Sons, Inc.

Horsley, S. L, Siles, K. E., Mundry, S., Love, N., & Hewson, P. K. (2010). *Designing Professional Development Teachers of Science and Mathematics* (3rd ed.). New Delhi: Corwin A Sage Company.

Jaconben, D., Eggen, P., Kauchak, D., & Dalaney, C. (1985). *Methods for Teaching: A Skills Approach* (2nd ed.). Columbus: A Bell & Howell Company.

Joyce, B., & Weil, M. (1980). *Models of Teaching* (2nd ed.). New Jersey: Prentice-Hall, Inc.

Kask, U., & Rawn, J. D. (1993). *General Chemistry*. London: Wm.C. Brown Communications, Inc.

McCombs, B. L., & Whisler, J. S. (1997). *The Learner-centered Classroom and School: Strategies for Increasing Student Motivation and Achievement*. San Francisco: John Wiley & Sons, Inc.

Meece, J. L. (2002). *Child & Adolescent Development for Educators* (2nd ed.). New York: McGraw-Hill.

Moon, B., & Mayes, A. S. (1996). *Teaching and Learning in the Secondary School*. London and New York: Open University.

Newburg, N. F. (1971). *The Teaching of Chemistry in Tropical Secondary Schools*. London: Butter & Tanner.

Passer, M. W., & Smith, R, E. (2007). *Psychology: The Science of Mind and Behavior* (3rd ed.). New York: McGraw-Hill, Inc.

Ray, B. (2009). *Modern Methods of Teaching Chemistry.* New Delhi: A P H Publishing Corporation.

Sang, M. S. (2003). *An Education Course for K.P.L.I, Theme 1.* Subang Jaya: Kumpulan Budiman Sdn Bhd.

Sang, M. S. (2003). *An Education Course for K.P.L.I, Theme 2.* Subang Jaya: Kumpulan Budiman Sdn Bhd.

Schunk, D. H. (2004). *Learning Theories: An Educational Perspective* (4th ed.). Upper Saddle River, New Jersey: Pearson Prentice Hall.

Singh, Y. K. (2009). *Teaching Practice:Lesson Planning*. New Delhi: APH Publishing Corporation

Slavin, R. E. (2003). *Educational Psychology: Theory and Practice* (7th ed.). New York: Pearson Education, Inc.

Sunita, G. H. (2012). *A Comparative Study of Piaget's and Vygotsky's Cognitive Development Theory*. Lokavishkar International E-Journal, ISSN 2277-727X, Vol-1, Issue-II, Apr-May-June 2012. Retrieved November 4, 2013, from www.liirjj.org.

Superfine, W. (1999). *Why Use Activity-based Learning in the Young Learner Classroom?* Retrieved October 16, 2013, from http://www.esecs.ipleiria.pt/f1412.1.pdf

Trilling, B., & Fadal, C. (2009). *21st Century Skills, Learning for Life in Our Times*. San Francisco: Jossey-Bass.

Unesco. (1984). *Teaching School Chemistry*. London: Imprimerie Floch, Mayenne.

Woolfolk, A. E. (1990). *Educational Psychology* (4th ed.). London: Prentice-Hall, Inc.

CHAPTER 3

Research Methodology

The purpose of this study is to investigate the effects of activity-based learning on Grade Ten students in teaching chemistry. Quantitative research methodology was used to compare students' chemistry achievement between two groups; experimental group and control group.

3.1 Sample

Two schools were selected by random sampling method to carry out the research. The first school, No (2), BEHS, Lanmadaw was from Yangon Region and the second one, (Sub) BEHS, Ayoda was from Ayeyarwaddy Region. Participants in this study were Grade Ten students from the selected schools. Population and sample size are presented in Table 3.1.

Table 3.1 Population and Sample Size

Name of School	Number of Population	Number of Subjects
No (2), BEHS, Lanmadaw	180	60
(Sub) BEHS, Ayoda	65	52

3.2 Research Design

The pretest-posttest control group design, one of the true experimental designs, was adopted in this study (see Table 3.2).

Table 3.2 Research Design

Group	Assignment	Number of Students		Pretest	Treatment	Posttest
		LS	AS			
Experimental	Random	30	26	BCK	Teaching chemistry with activity-based learning	CA
Control	Random	30	26	BCK	Traditional teaching method	CA

Note: BCK = Basic Chemistry Knowledge, CA = Chemistry Achievement

LA = No (2), BEHS, Lanmadaw, AS = (Sub) BEHS, Ayoda

Activity records are presented in Figure 3.1, Figure 3.2, Figure 3.3 and Figure 3.4**.**

Figure 3.1 Activity-based Learning of Students at B.E.H.S (2) Lanmadaw

Figure 3.2 Activity-based Learning of Students at (Sub) B.E.H.S Ayoda

Figure 3.3 Activity-based Learning of Students at (Sub) B.E.H.S Ayoda

Figure 3.4 Activity-based Learning of Students at B.E.H.S (2) Lanmadaw

3.3 Instrument

Two instruments, a pretest and a posttest, were used in this study.

(a) Pretest

This test was constructed to measure the basic chemistry knowledge of the students. It consisted of true or false items, completion items, multiple choice items, matching items, short questions and long questions items. Test items were constructed based on the previous lessons of Grade Ten Chemistry Textbook. The test was constructed according to the advice and guidance of the supervisor. Table of specifications for the pretest was presented (see Table 3.3). In order to get validation, the copies of pretest questions were distributed to two professors, two associate professors and one assistant lecturer. According to their suggestions, the test was modified again. On 5th December, 2013, the pilot test was held with (10) Grade Ten students at Yangon Institute of Education, Practising High School. The allocated time for this test was (90) minutes, and the given marks were 50. Marking scheme for the pretest was also presented (see Appendix C). The U-L Index method (Stocklein, 1957, cited in Sevilla, 1992) was used to determine whether each test item was appropriate or not. The findings of item analysis were presented (see Appendix D). The difficulty indices and discrimination indices of the items were within the acceptable range 0.20 to 0.80 and 0.30 to 0.80.

Table 3.3 Table of Specification for Pretest

Number	Chapter	Knowledge Level		Comprehension Level		Application Level	
		Number of Item	Percentage	Number of Item	Percentage	Number of Item	Percentage
1	Chapter (9)	4	33.3%	1	8.3%	3	100%
2	Chapter (10)	6	50%	1	8.3%	_	_
3	Chapter (11)	2	16.7%	10	83.4%	_	_
Total		12	100%	12	100%	3	100%

(b) Posttest

This test was constructed to measure chemistry achievement of the students. It consisted of true or false items, completion items, multiple choice items, matching items, short questions and long questions items. The students had to answer all the questions and there were no choice of items in each section. Test items were constructed based on Grade Ten Chemistry Textbook. The test was constructed according to the advice and guidance of the supervisor. Table of specifications for the posttest was presented (see Table 3.4). In order to get validation, the copies of posttest questions were distributed to two professors, two associate professors and one assistant lecturer. According to their suggestions, test items were modified again. On 9th January, 2014, the pilot test was administered with (10) Grade Ten students at BEHS, Ngaputaw. The allocated time for this test was (90) minutes, and the given marks were 50. The required marking scheme was also presented (see Appendix G). The U-L Index method (Stocklein, 1957, cited in Sevilla, 1992) was used in this study. The findings of item analysis were presented (see Appendix H). The difficulty indices and discrimination indices of the items were within the acceptable range 0.20 to 0.80 and 0.30 to 0.80.

Table 3.4 Table of Specification for Posttest

Number	Chapter	Knowledge Level		Comprehension Level		Application Level	
		Number of Item	Percentage	Number of Item	Percentage	Number of Item	Percentage
1	Chapter (14)	8	66.7%	3	27.3%	2	50%
2	Chapter (15)	4	33.3%	8	72.7%	2	50%
Total		12	100%	11	100%	4	100%

3.4 Learning Materials

Learning materials were selected from Grade Ten Chemistry Textbook. Two chapters such as Chapter (14) Acids, Bases and Salts, and Chapter (15) Carbon and its Compounds were chosen as learning materials.

3.5 Procedure

This study is to find out the effects of activity-based learning on Grade Ten students in teaching chemistry. Students are divided into two groups, an experimental group and a control group. In order to measure the previous knowledge of all selected students, a pretest was administered before the treatment.

In each school, the experimental group was taught by using activity-based learning and the control group was taught by using traditional teacher-led instruction.

The treatment period was from 9th December, 2013 to 20th December, 2013 for No (2), BEHS, Lanmadaw. In (Sub) BEHS, Ayoda, the treatment period was from 13rd January, 2014 to 24th January, 2014. Each class was taken two periods per day. One period lasted (45) minutes. Therefore, the total time for this experiment was (13.5) hours in each school. At the end of the treatment period, all selected students had to sit for posttest. The allocated time for this posttest was (90) minutes and the given marks were 50. Sample lesson plan for the treatment of the experimental group was presented in Appendix I.

Procedures for traditional teacher-led instruction and procedures for teaching chemistry by activity-based learning were as follows:

Procedures for Teaching Chemistry by Traditional Teacher-led Instruction

Procedures for traditional teacher-led instruction are as follows:

- Teach by telling,
- Make students to memorize the facts, rules and formulae, and
- Give explanations how to write chemical equations.

Procedures for Teaching Chemistry by Activity-based Learning

Procedures for teaching chemistry by activity-based learning are as follows:

- Use hands-on activities,
- Make sure that all the students actively participate in classroom activities,
- Use questions to different ideas and opinions,
- Encourage cooperative group to discuss about problems,
- Attribute success to effort and ability, and
- Be a facilitator of learning.

References

Basic Education Curriculum, Syllabus and Textbook Committee. (2011). *Chemistry*. *Grade Ten*. Myanmar: Aung San Printing Office.

Sevilla, C. G. (1992). *Research Methods*. Manila: Rex Book Store.

CHAPTER 4

Findings and Interpretations

This chapter deals with the analysis of the data, findings and interpretations of the experimental study.

4.1 Quantitative Research Findings

This study was designed to find out the effects of activity-based learning on Grade Ten students in teaching chemistry. It involved two groups such as experimental group and control group, both of which were formed by random assignment. Both groups were conducted a pretest before the treatment was given. The results of *t* - tests, the mean scores, standard deviations and mean differences of both groups for pretest are presented as follows:

Table 4.1 *t* - Values for Pretest Chemistry Achievement Scores

School	Group	N	M	SD	MD	*t*	df	Sig (2 tailed)
LS	Experimental	30	26.00	10.37	.07	.03	58	.980 (n.s)
	Control	30	25.93	9.93				
AS	Experimental	26	10.27	4.01	.00	.00	50	1.000 (n.s)
	Control	26	10.27	4.01				

Note: *p < 0.05, n.s = not significant

LS = No. (2), BEHS, Lanmadaw, AS = (Sub) BEHS, Ayoda

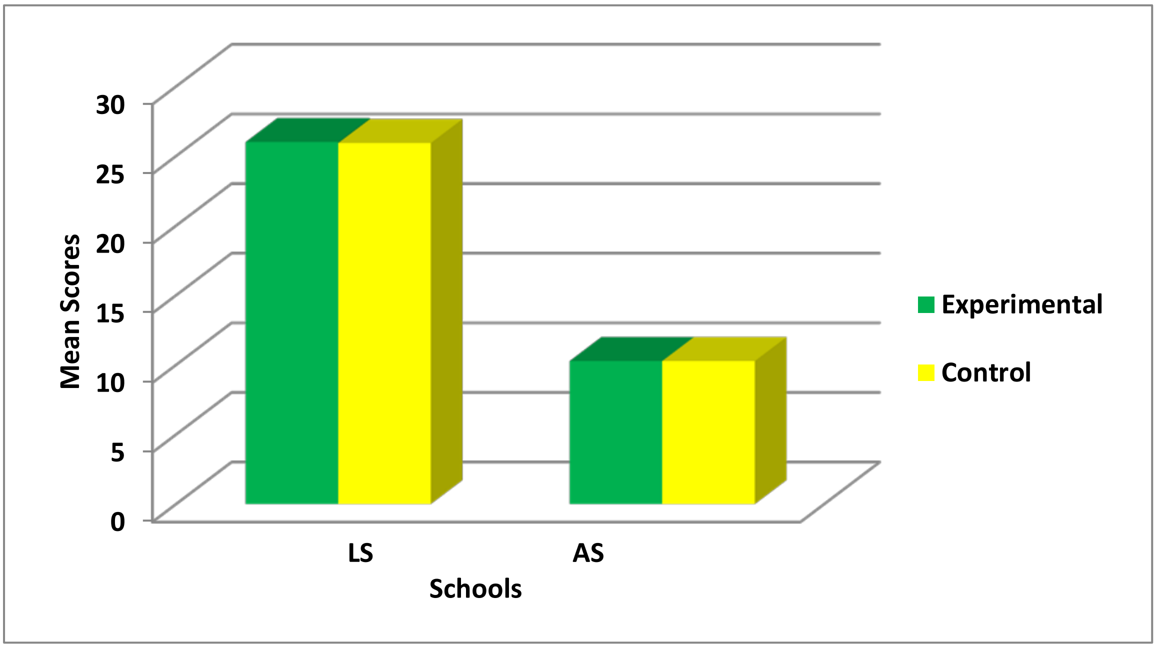

Figure 4.1 The Comparison of Mean Scores for Pretest

LS = No. (2), BEHS, Lanmadaw, AS = (Sub) BEHS, Ayoda

The mean scores of the experimental groups and the control groups were nearly the same marks (see Table 4.1). It showed that there was no difference between the experimental groups and the control groups for the scores on the pretest in each school (see Figure 4.1). Thus, the previous knowledge of the experimental groups and the control groups were equivalent.

After pretest, one group received traditional teacher-led instruction and another was taught by activity-based learning. During the treatment period, an activity record was written systematically (see Appendix J). Then, both groups were administered a posttest. Posttest scores could be directly compared using independent samples *t* - test. The results in regard to *t* - tests, the mean scores, standard deviations and mean differences of both groups for posttest are presented as follows:

Table 4.2 *t* - Values for Posttest Chemistry Achievement Scores

School	Group	N	M	SD	MD	*t*	df	Sig (2 tailed)
LS	Experimental	30	23.63	10.06	11.33	4.74	58	.000***
	Control	30	12.3	8.39				
AS	Experimental	26	16.88	7.27	2.73	1.225	50	.226 (n.s)
	Control	26	14.15	8.72				

Note: ***p < 0.001, n.s = not significant

LS = No. (2), BEHS, Lanmadaw, AS = (Sub) BEHS, Ayoda

According to the posttest chemistry achievement scores, the mean score of the experimental group was significantly higher than that of the control group in No. (2), BEHS, Lanmadaw. It showed that the experimental group was significantly different from the control group in No. (2), BEHS, Lanmadaw. On the other hand, the mean score for the experimental group was not higher than that for the control group in (Sub) BEHS, Ayoda. Therefore, there was no significant difference between the experimental group and the control group in (Sub) BEHS, Ayoda (see Table 4.2 and Figure 4.2).

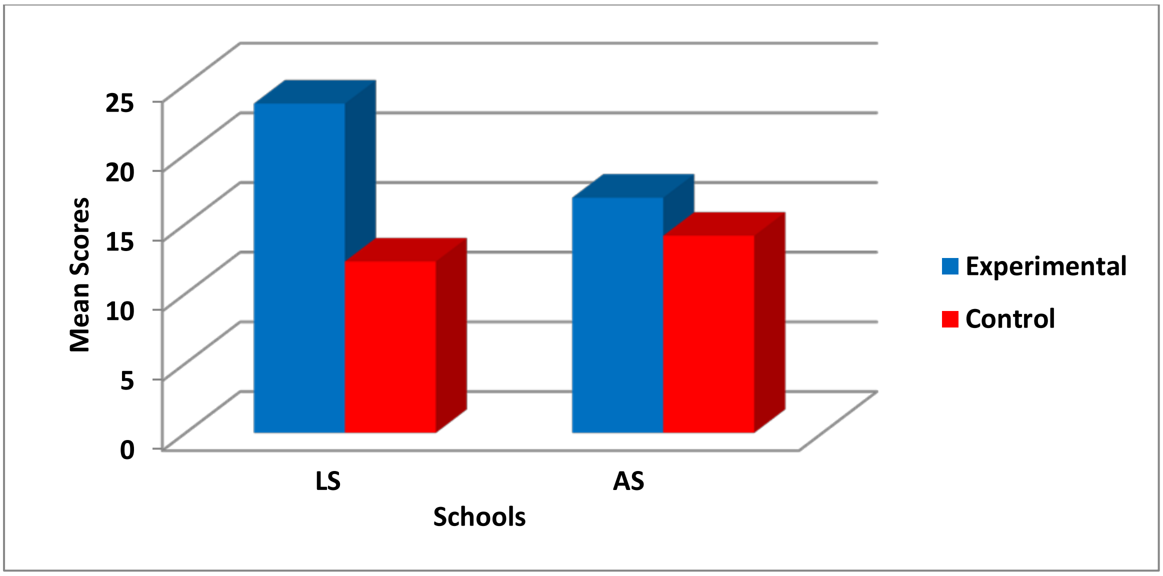

Figure 4.2 The Comparison of Mean Scores for Posttest

LS = No. (2), BEHS, Lanmadaw, AS = (Sub) BEHS, Ayoda

For No. (2), BEHS, Lanmadaw, it can be interpreted that teaching chemistry by activity-based learning has significant effects on chemistry achievement of the students and positively contributed to the chemistry teaching at the high school level. For (Sub) BEHS, Ayoda, it can be concluded that traditional teacher-led instruction has significant effects on chemistry achievement of the students and positively contributed to the chemistry teaching at the high school level.

Table 4.3 *t* - Values for Scores on Knowledge Level Questions

School	Group	N	M	SD	MD	*t*	df	Sig (2 tailed)
LS	Experimental	30	9.26	4.03	3.73	3.88	58	.000***
	Control	30	5.53	3.4				
AS	Experimental	26	5.73	2.52	-1.08	-1.31	50	.197
	Control	26	6.81	3.36				(n.s)

Note: ***p < .001, n.s = not significant

LS = No. (2), BEHS, Lanmadaw, AS = (Sub) BEHS, Ayoda

In regard to the scores on the knowledge level questions, the mean score of the experimental group was significantly higher than that of the control group in No. (2), BEHS, Lanmadaw. It showed that there was a significant difference between the experimental group and the control group for scores on the knowledge level questions in No. (2), BEHS, Lanmadaw. However, the mean score of the experimental group was not higher than that of the control group in (Sub) BEHS, Ayoda. So, there was no significant difference between the two groups in (Sub) BEHS, Ayoda (see Table 4.3 and Figure 4.3).

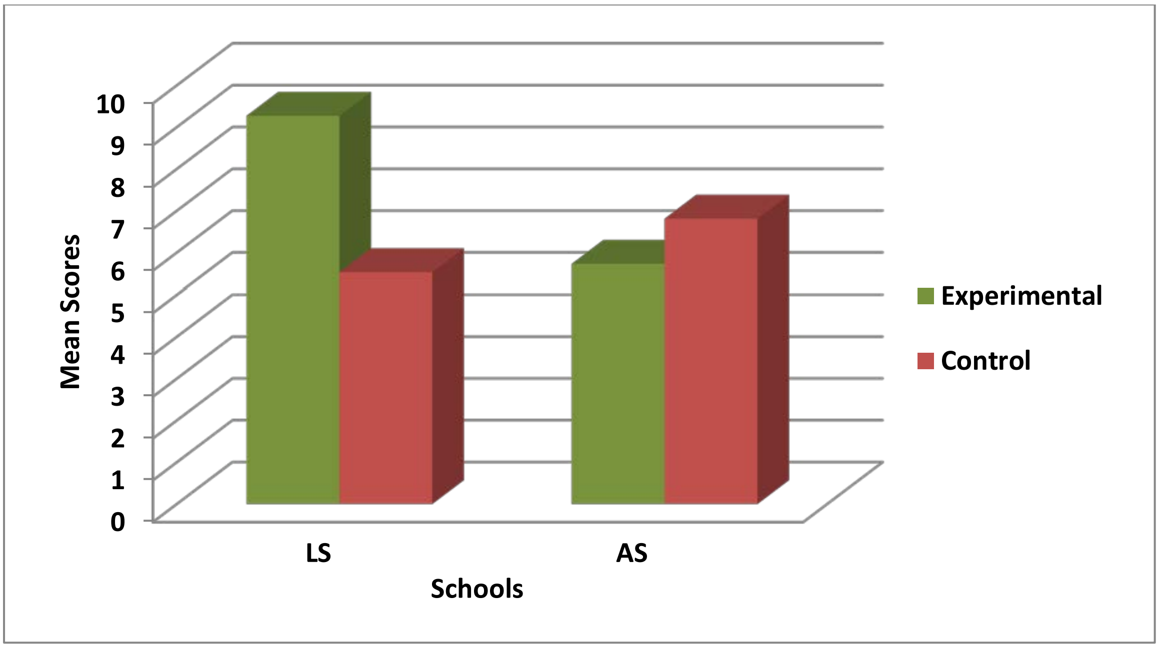

Figure 4.3 The Comparison of Mean Scores for Knowledge Level Questions

LS = No. (2), BEHS, Lanmadaw,   AS = (Sub) BEHS, Ayoda

For No. (2), BEHS, Lanmadaw, it can be interpreted that teaching chemistry by activity-based learning could bring about the progress of students' ability to recall or recognize information. For (Sub) BEHS, Ayoda, it can be concluded that teaching chemistry by activity-based learning could not bring about the progress of students' ability to recall or recognize information.

Table 4.4 *t* - Values for Scores on Comprehension Level Questions

School	Group	N	M	SD	MD	*t*	df	Sig (2 tailed)
LS	Experimental	30	8.93	3.47	4.07	4.9	58	.000***
	Control	30	4.86	2.93				
AS	Experimental	26	7.61	3.38	1.96	2.144	50	.037*
	Control	26	5.65	3.21				

Note: ***p < .001,   *p < .05

LS = No. (2), BEHS, Lanmadaw,   AS = (Sub) BEHS, Ayoda

Results of comprehension level questions showed that the mean scores of the experimental groups were significantly higher than those of the control groups in No. (2), BEHS, Lanmadaw and (Sub) BEHS, Ayoda (see Table 4.4). It showed that there were significant differences between the two groups for two selected schools on the scores of the comprehension level questions (see Figure 4.4).

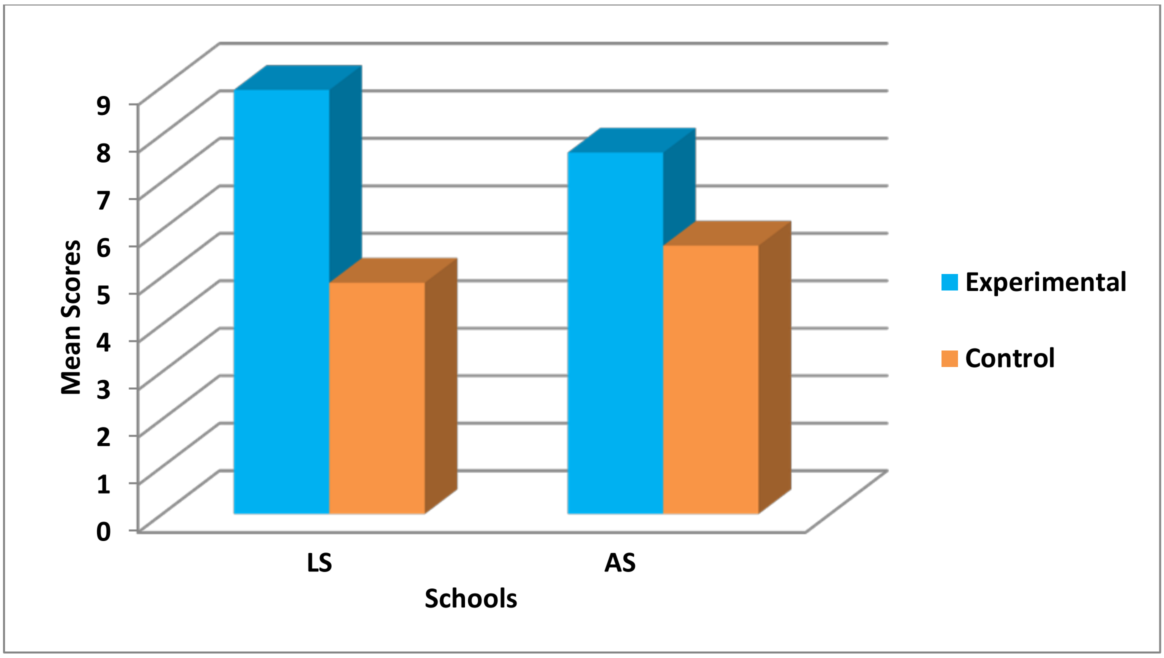

Figure 4.4 The Comparison of Mean Scores for Comprehension Level Questions

LS = No. (2), BEHS, Lanmadaw, AS = (Sub) BEHS, Ayoda

For No. (2), BEHS, Lanmadaw and (Sub) BEHS, Ayoda, it can be interpreted that the use of activity-based learning in chemistry teaching could bring about the improvement of students' understanding.

Table 4.5 *t* - Values for Scores on Application Level Questions

School	Group	N	M	SD	MD	*t*	df	Sig (2 tailed)
LS	Experimental	30	5.43	3.99	3.53	3.95	58	.000***
	Control	30	1.9	2.84				
AS	Experimental	26	3.53	3.39	1.88	2.082	50	.042*
	Control	26	1.65	3.12				

Note: ***p < .001, *p < .05

LS = No. (2), BEHS, Lanmadaw, AS = (Sub) BEHS, Ayoda

With regard to the scores on the application level questions, the mean scores of the experimental groups were significantly higher than those of the control groups in No. (2), BEHS, Lanmadaw and (Sub) BEHS, Ayoda (see Table 4.5). It showed that there were significant differences between the two groups for two selected schools on the scores of the application level questions (see Figure 4.5).

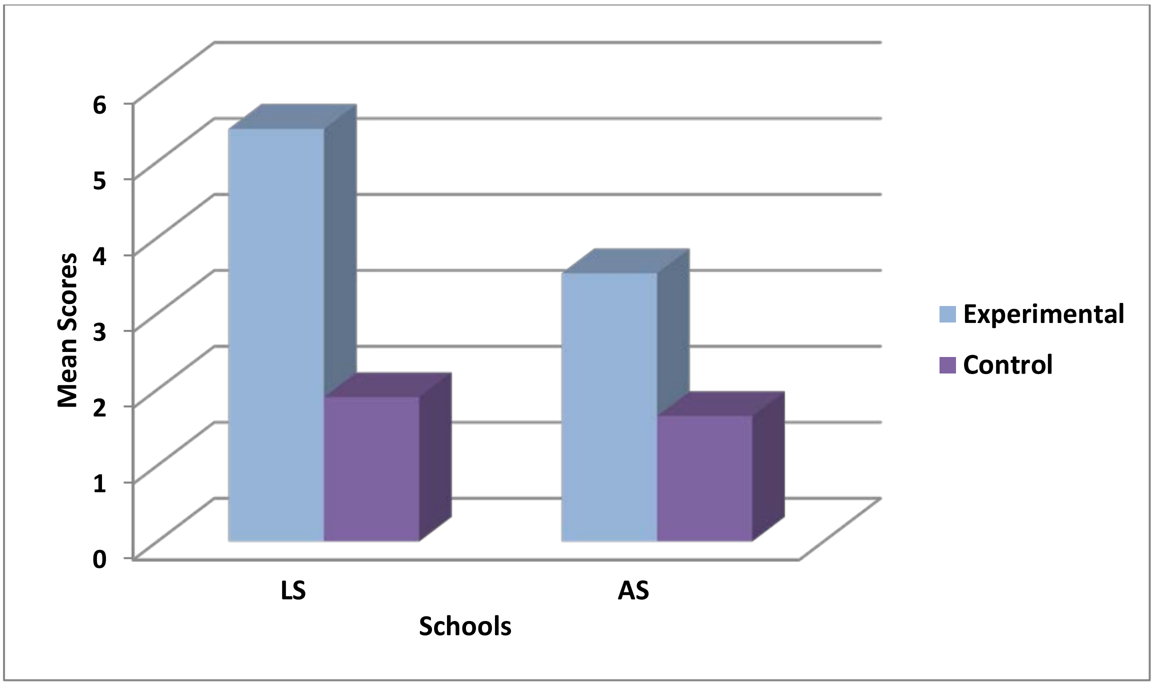

Figure 4.5 The Comparison of Mean Scores for Application Level Questions

LS = No. (2), BEHS, Lanmadaw, AS = (Sub) BEHS, Ayoda

For No. (2), BEHS, Lanmadaw and (Sub) BEHS, Ayoda, it can be interpreted that activity-based learning could bring about the development of students' ability to apply previously learned information for problem solving.

4.2 Summary of Quantitative Findings

The results of research findings from the two selected schools were as follows:

- There was a significant difference between the experimental group and the control group for No. (2), BEHS, Lanmadaw, but there was no significant difference for (Sub) BEHS, Ayoda on the scores of chemistry achievement.
- There was a significant difference between two groups for No. (2), BEHS, Lanmadaw, but there was no significant difference for (Sub) BEHS, Ayoda on the scores of knowledge level questions.
- There were significant differences between two groups for No. (2), BEHS, Lanmadaw and (Sub) BEHS, Ayoda on the scores of comprehension level questions.
- There were significant differences between two groups for No. (2), BEHS, Lanmadaw and (Sub) BEHS, Ayoda on the scores of application level questions.

CHAPTER 5

Discussion and Conclusion

5.1 Discussion

In the experimental group, students were taught by activity-based learning with the help of activities that is favoured by constructivism. The teaching approach is student-centered approach. Exhaustive activity cards and chemical apparatus were prepared for students to become active in the learning process. The role of the teacher was a guide on the side instead of a sage on the stage. In the control group, the teacher simply provided facts, rules and formulae to students and explained how to write chemical equations. Teacher-centered approach was emphasized.

As per the comparison of mean scores on knowledge, comprehension and application level questions for No. (2), BEHS, Lanmadaw, the findings showed that there was a significant difference between the experimental group and the control group. The students from the experimental group were given the opportunities to keep the objectives in mind, participate actively in learning activities, work in small groups and understand the cooperative learning principles, and collect, analyze and conclude the information cooperatively. This result is in line with Rao (2009) who stated that the acquisition of active knowledge requires hands-on experience or learning which cements the activities in the students' minds. This result is in consistent with Gallagher (2000, cited in Beeghly , 2007) who suggested that understanding and application can be encouraged by having students to work in groups to develop explanations and describe applications.

On the other hand, there was no significant difference between the experimental group and the control group of (Sub) BEHS, Ayoda for the scores on knowledge level questions but there were significant differences on comprehension and application level question. It can be said that activity-based learning is effective to some extent in chemistry teaching. This finding is not in line with Duvarci (2010) who found that the students found the activities entertaining and helpful for remembering the subject matters. This result is in line with Churchill (2003, cited in Khan, 2012) who described that activity-based learning helps students to 'construct mental models that allow for 'higher-order' performance such applied problem solving and transfer of information and skills. However, there was no significant difference for (Sub) BEHS, Ayoda on the scores of knowledge level question. A family's socioeconomic status (SES) is a major influence on the school success of children (Surin, 2005, cited in Cruickshank, 1999). Socioeconomic status is measured in terms of parent education, occupational status and income. Since parents were low in SES, they could not help to ensure children have a good attitude towards learning and did not know how to create a home conducive to learning. Although parents knew the importance of education, they failed to promote it in the lives of their children. Therefore, students' educational results could be unfortunate. Parents are their children's first and most influential teachers. What parents do to help their children learn is important to academic success. Therefore, parental involvement helps children learn more effectively (U.S. Department of Education, 1986, cited in Berger, 1987).

5.1.1 Suggestions

Education is the process by which human behavior can be changed (Htoo Htoo Aung, 2011). It is a social activity which involves people working cooperatively and serving each other. It empowers people. Science is perhaps the most ideal school subject to improve students' thinking ability because it emphasizes inquiry, which in turn encourages them to construct their own knowledge through the active investigation of objects and events (Collette, 1989). Similarly, chemistry is part of the total education provision and the chemistry content is gained so as to enhance learning in the cognitive, personal and social domains (Dayal, 2009). It is widely believed that practical work is inherently valuable (Unesco, 1984). It must, however, emphatically stated that 'doing' does not necessarily produce retention. The students need to be intellectually engaged in thinking about science.

The three main conditions required for chemical education to develop as a scientific discipline only via scientifically based methods are objective observation, powerful methods and techniques, and predictive ability. There are also three goals set in attempts to improve chemistry teaching for the future. One is closer integration of classroom and laboratory activities and concepts. A second is a continuing search for challenging, relevant, interesting 'hands-on' experiments for students that reach beyond verification of known information and allow them to explore reactively. Third, a continual push for the development of low-cost equipment, manufactured within a country through using indigenous materials and talent whenever possible, is essential in developing countries.

Activity-based learning is a cognitive-learning theory which is basically a 'constructivist' learning theory (Hein, 1991, cited in Khan, 2012). According to constructivist view of learning, students construct their own knowledge and learning process based on the previous experience. This theory states that learning takes place when psychological environment of an individual interacts with a particular structure. Traditional teaching methods are not suitable for tactile learning because it needs experience and involves manipulation of materials (Kolb, 1984, cited in Khan, 2012). According to Hull (1999, cited in Khan, 2012), the majority of students are unable to make connections between what they are learning and how that knowledge will be used. One of the reasons is that teachers do not contextualize their teaching-learning process. So, activity-based learning is necessary to contextualize the students' learning.

Relating chemistry to students' personal experiences and societal problems is an essential component of activity-based learning. Especially, relating chemistry to practical, civic, professional, recreational and cultural events that are familiar and relevant to students' backgrounds, and experiences can promote chemistry literacy, motivate students and help them learn to value chemistry (Salend, 2001). Learning activities if based on 'real life experiences' help students to transform knowledge or information into their personal knowledge which they can apply in different situations for future life (Edward, 2001, cited in Khan, 2012). Students learn about the process to solve the problem. Effective teaching-learning process is not possible without students' motivation. So, intrinsic motivation is important to activity-based learning. Finally, students must talk about what they are learning, write about it, relate it to past experiences, and apply it to their daily lives.

Activity-based learning is used to teach chemistry to students with disabilities. Teachers often use a content-oriented approach that focuses on factual text-based information through textbooks and teacher-directed presentations. These approaches require that students have certain levels of reading, writing and memory skills (Scruggs, 1993, cited in Salend, 2001). Consequently, students with disabilities do not benefit from it and often receive low grades and perform significantly below their general education peers. However, they can learn chemistry through an activity-oriented approach that reduces the reliance on textbooks, lectures and pencil-and-paper tests. This kind of approach seeks to promote learning by providing students with experiences that allow them to discover and experiment with chemistry. Through discovery and inquiry, teachers involve students in creating and expanding their knowledge and understanding about the content area.

One of the primary functions of education is the development of a society of social and self-responsible individuals (Moore, 2007). A complete education must also focus on those thinking skills that will enable students to be responsible and to be effective problem solvers. Thinking can be defined as the act of withholding judgment in order to use past knowledge and experience to find new information, concepts, or conclusions. This act requires individual responsibility. During the activities, students are given opportunities to think about their views and the views of others. It must, however, be necessary to let students make final decisions. Many educators suggest that thinking skills are the basis on which all other skills are developed. All persons have the potential for creative thinking. It occurs as the result of learning beyond the gathering of rote information. It is often equated with curiosity, imagination, discovery and invention. Besides, another one is critical thinking skills which should be taught directly: comparing, interpretations, observing, summarizing, classifying, decision making, creating and criticizing (Sadker, 2005).

A skill is a capacity or competence: the ability successfully to perform a task, whether intellectual or manual (Moon, 1966). The acquisition of a skill may be dependent on the possession of certain knowledge and/or concepts. Activity-based learning can reinforce social skills for which group work will involve the children in decision-making, turn-taking, mutual support and constructive feedback. An attitude is a disposition to think or act in a particular way in relation to oneself and to other individuals in society. In this study, the students enjoyed the activity-based learning, actively participated in the activities and achieved success in their academic skills. Consequently, activity-based learning can increase the students' positive attitudes and interest towards chemistry.

Moreover, teachers and parents need to have their appropriate expectations for children; and when children know what the expectations are, they can achieve them (Morrison, 1988). In schools where little is done to nurture parental involvement and support, teachers and parents sometimes regard themselves as adversaries (Armstrong, 1989). Parents who are not involved in the school program know little about what their children are experiencing. Actually, children see parental involvement as a sign that their parents value education and are not just "leaving them off" and forgetting them (Morrison, 1988). So, it is necessary to develop high levels of parental involvement so as to know and increase the students' progress in education but it requires hard work.

5.1.2 Summary of Suggestions

The summary of suggestions is as follows:

- Activity-based learning is helpful to contextualize the students' learning.

- Activity-based learning can help students apply the same real life experiences in their practical life.
- Activity-based learning is used to help many students with disabilities learn chemistry.
- Activity-based learning can help develop social, thinking and academic skills.
- Activity-based learning positively contributes to increase the students' positive attitudes and interest towards chemistry.

5.1.3 Recommendations for Further Research

On the basis of the results obtained from the analysis of the data, the following recommendations could be made.

- The study about activity-based learning should be replicated in other science disciplines such as physics and biology.
- The study concerning activity-based learning should be replicated in all grades from elementary to university levels.
- The numbers of students were 60 from No. (2), BEHS, Lanmadaw and 52 from (Sub) BEHS, Ayoda in this study. Therefore, the sample size can be increased in a more generalizable result concerning the activity-based learning.
- The study regarding activity-based learning was carried out in Yangon and Ayeyarwaddy Regions. Therefore, it should be replicated for other states and regions.
- It is certain that there are other topics that are appropriate for developing activities in chemistry. Moreover, the effects of activity-based learning for such topics should be found out later.

5.2 Conclusion

Learning is important to the individual. The achievement of learning objective, in general, can be assessed in the changes of students' behavior through their learning activities. All learning processes can be implemented through discovery learning. In order to acquire more information, concept, principle and law, activity-based learning is suitable for teaching chemistry. Chemistry is a central science and has become more and more important in the 21^{st} century. Activity-based learning encourages students to "learn how to learn" through different activities and real life problems. Since it helps the students solve a problem in hand, their understanding and life-long learning are increased. During the activities, the students need an input of "doing", and are engaged with the world, from which they construct a meaning. So, activity-based learning is an active and engaging process for students' learning. Moreover, students' learning experiences are connected with other human beings such as peers and teacher where they cooperate, negotiate, express ideas in a variety of contexts and consider other points of view, and then these learning experiences are interwoven with life experiences. Therefore, activity-based learning is also a social activity and occurs contextually. Activity-based learning is helpful to teach many disabled students who benefit from hands-on experiences on learning. On the other hand, activity-based learning takes time in which the students need to revisit ideas, ponder them, try them out, play with them, and use them. Consensus exists that learning by doing is the most effective way for students to learn something. Through the use of manipulatives and various activities, students are encouraged to infuse chemistry in their everyday life and deal with the subject confidently. Moreover, since students are motivated by solving real-world problems, they express a preference for doing rather than listening. During the activities, the active participation of the students was observed and they found chemistry more enjoyable.

Therefore, it can be said that activity-based learning can force the students to master subject matter, acquire social skills and be able to think as much as possible. The activity-based learning creates a visible improvement in students' learning and so students like learning chemistry more than before. However, it is important for parents to actively involve themselves in the education of their children to create a better learning. The results of the study might be useful for the chemistry teachers who are open to use new methods or activities at the high school level. Therefore, activity-based learning can be adopted as a tool in attempting to improve chemistry teaching methodology.

References

Armstrong, D. G., Henson, K. T., & Savage, T. V. (1989). *Education: An Introduction* (3rd ed.). New York: Macmillan Publishing Company.

Beeghly, D. G., & Prudhoe, C. M. (2007). *Litlinks: Activities for Connected Learning in Elementary Classrooms*. New York: McGraw-Hill, Inc.

Berger, E. H. (1987). *Parents as Partners in Education* (2nd ed.). Columbus: A Bell and Howell Information Company.

Collette, A. T., & Chiappetta, E. L. (1989). *Science Instruction in the Middle and Secondary Schools* (2nd ed.). Columbus: Merrill Publishing Company.

Cruickshank, D., Metcalf, K. K., & Jenkins, D. B. (1999). *The Act of Teaching* (2nd ed.). Columbus: McGraw-Hill, Inc.

Dayal, D., Bhatt, R., & Ray, B. (2009). *Modern Methods of Teaching Chemistry*. New Delhi: A P H Publishing Corporation.

Duvarci, D. (2010). *Activity-based Chemistry Teaching: a Case of "Elements and Compounds*". Retrieved October 16, 2013, from http://www.sciencedirect.com/science/article/pii/S1877042810004027

Htoo Htoo Aung, Dr. (2011). *NFPE: A Helping Hand*. Yangon: Shwe Minn Tha Press.

Khan, M., Niaz Muhammad, Dr., Ahmed, M., Saeed, F., & Khan, S. A. (2012). *Impact of Activity-Based Teaching on Students' Academic Achievements in Physics at Secondary Level*. Retrieved October 16, 2013, from http://www.savap.org.pk/journals/ARlnt./Vol.3%281%29/2012%283.119%29.pdf

Lombardi, M. M. (2007). *Authentic Learning for the 21st Century: An Overview*. Retrieved October 8, 2013, from http://net.educause.edu/ir/library/pdf/eli3009.pdf

Moon, B., & Mayes, A. S. (1996). *Teaching and Learning in the Secondary School*. London and New York: Open University.

Moore, K. D. (2007). *Classroom Teaching Skills* (6th ed.). New York: McGraw-Hill, Inc.

Morrison, G. S. (1988). *Early Childhood Education Today* (4th ed.). Columbus: A Bell and Howell Information Company.

Rao, V. K. (2009). *Educational Technology*. New Delhi: A P H Publishing Corporation.

Sadker, M. P., & Sadker, D. M. (2005). *Teachers, Schools and Society* (7th ed.). New York: McGraw-Hill, Inc.

Salend, S. J. (2001). *Using an Activities-based Approach to Teach Science to Students with Disabilities*. Retrieved October 8, 2013, from www.catea. gatech.edu / scitrain/kb/ FullText-Articles /Salend-pdf

Unesco. (1984). *Teaching School Chemistry*. London: Imprimerie Floch, Mayenne.

Appendix A

Validation (Pretest)

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uRefawmfonf(**A Study of the Effects of Activity-based Learning on Grade Ten Students in Teaching Chemistry**) acgif;pOfjzifh r[mynma&;bGJUusrf;udk a&;om;jyKpkvsuf½Sdygonf/ usrf;twGufokawoevkyfief;aqmif½Guf&mwGif e0rwef; (Grade-10) ausmif;om;^ausmif;olrsm;tm; e0rwef; "mwkaA'bmom&yftcef;(9)? (10)? (11) oifcef;pmrsm;rS "mwkaA'qdkif&m tajccHA[kokwudk ppfaq;&eftwGuf yl;wGJyg ar;cGef;rsm;udk a&;om;jyKpkxm;ygonf/

q&mBuD;^q&mrBuD;rsm;\ tawGUtBuHKt&þar;cGef;rsm;onf e0rwef; (Grade – 10) ausmif;om;^ausmif;olrsm;\ "mwkaA'qdkif&mtajccHA[kokwudkppfaq;&efqDavsmfrI ½Sd^r½Sd ESifhjyKjyif&efvdktyfygu yl;wGJygpm½GufwGif tBuHjyKay;yg&ef av;pm;pGm wifjy tultnDawmif;cHtyfygonf/

usrf;BuD;Muyfol	av;pm;rIjzifh
a'gufwmrMunfaqG	qvdkif;wifxGef;
vufaxmufuxdu	2-r[mynmoifjy-11
oifjyenf;Xme	&efukefynma&;wuúodkvf
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tBuHjyKol\ udk,fa&;rSwfwrf;tusOf;

trnf	-------------------------------&mxl;
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ausmif;^Xme	-------------------------------
ynmt&nftcsif;	-------------------------------
pkpkaygif;vkyfouf	-------------------------------vkyfouf
(ynma&;^oifjyenf;Xme)	-------------------------------
"mwkaA'bmom&yfESifhywfoufaom	
tawGUtBuHKvkyfouf	-------------------------------

Questionnaire for Validation

(Pretest)

Grade (10) Chemistry Time Allowed (1:30) hours

1. Write TRUE or FALSE for each of the following statements. (4 marks)
   (a) One molecule of H_2O is 18 times lighter than 1 atom of H.
   (b) Ozone is used in ventilation systems to purify air and to sterilize water.
   (c) A red hot iron wire burns in oxygen with a yellowish flame.
   (d)Oxygen in the atomic state is called nascent oxygen.

2. Fill in the blanks with a suitable word or words. (4 marks)
   (a) One mole of any gas occupies ….. at STP.
   (b) Manganese (IV) oxide is used to ….. hydrogen peroxide to oxygen.
   (c) The combination of a substance with oxygen is called ….. .
   (d) Hydroxides which are soluble in water are called ….. .

3. Select the correct word or words given in the brackets. (4 marks)
   (a) At the same temperature and pressure, (similar, different, equal) volumes of all gases contain the same number of molecules.
   (b) (Metals, Non-metals, Salts) react with oxygen to give oxides.
   (c) Soluble acidic oxides react with basic oxides to give (normal salt, salt and water, acid solutions).
   (d) Non-metallic oxide is called a (an) (basic, acidic, neutral) oxide.

4. Match each of the items given in list A with the appropriate item given in list B. (4marks)

List A	List B
(a) One molecule of oxygen	(i) neutral to litmus
(b) Oxygen	(ii) 2 atoms of oxygen
(c) Neutral oxide	(iii) shows neither basic nor acidic character
(d) Water	(iv) diatomic molecule

5. Answer the questions. (8 marks)

(a) Define (i) one mole of a substance, (ii) molar volume of the gas.

(b) Find the density of oxygen at STP. (O=16)

(c) What are the uses of CFCs?

(d) What are three classes of hydroxides? Give one example of each class.

6. Answer the questions. (12 marks)

(a) (i) What is the relative molecular mass of H_2SO_4? (H=1, S=32, O=16)

(ii) Find the mass of 67.2 dm^3 of sulphur dioxide at STP. (S=32, O=16)

(b) (i) What does ozone layer filter out?

(ii) How can you protect the ozone hole problem?

(c) Write equations for the following reactions.

(i) carbon dioxide reacts with sodium oxide

(ii) calcium hydroxide reacts with nitric acid.

7. Answer the questions. (14 marks)

(a) (i) What does STP mean? What are the numerical values?

(ii) Write down the activity series.

(iii) The mass of 3.17g of chlorine gas occupies the volume of 1dm^3at STP. What is the relative molecular mass of chlorine gas? Show that one molecule of chlorine contains 2 atoms of chlorine? (Cl=35.5)

(b) What are the main types of oxides? Answer with suitable example.

Suggestions

Appendix B

Question (Pretest)

Grade (10) Chemistry Time Allowed (1:30) hours

1. Write TRUE or FALSE for each of the following statements. (4 marks)

    (a) One molecule of H_2O is 18 times lighter than 1 atom of H.

    (b) Ozone is used in ventilation systems to purify air and to sterilize water.

    (c) A red hot iron wire burns in oxygen with a yellowish flame.

    (d)Oxygen in the atomic state is called nascent oxygen.

2. Fill in the blanks with a suitable word or words. (4 marks)

    (a) One mole of any gas occupies ….. at STP.

    (b) Manganese (IV) oxide is used to ….. hydrogen peroxide to oxygen.

    (c) The combination of a substance with oxygen is called ….. .

    (d) Hydroxides which are soluble in water are called ….. .

3. Select the correct word or words given in the brackets. (4 marks)

    (a) At the same temperature and pressure, (similar, different, equal) volumes of all gases contain the same number of molecules.

    (b) (Metals, Non-metals, Salts) react with oxygen to give oxides.

    (c) Soluble acidic oxides react with basic oxides to give (normal salt, salt and water, acid solutions).

    (d) Non-metallic oxide is called a (an) (basic, acidic, neutral) oxide.

4. Match each of the items given in list A with the appropriate item given in list B. (4 marks)

List A	List B
(e) One molecule of oxygen	(i) neutral to litmus
(f) Oxygen	(ii) 2 atoms of oxygen
(g) Neutral oxide	(iii) shows neither basic nor acidic character
(h) Water	(iv) diatomic molecule

5. Answer the questions. (8 marks)

(a) Define (i) one mole of a substance, (ii) molar volume of the gas.

(b) Find the density of oxygen at STP. (O=16)

(c) What are the uses of CFCs?

(d) What are three classes of hydroxides? Give one example of each class.

6. Answer the questions. (12 marks)

(a) (i) What is the relative molecular mass of H_2SO_4? (H=1, S=32, O=16)

(ii) Find the mass of 67.2 dm^3 of sulphur dioxide at STP. (S=32, O=16)

(b) (i) What does ozone layer filter out?

(ii) How can you protect the ozone hole problem?

(c) Write equations for the following reactions.

(i) carbon dioxide reacts with sodium oxide

(ii) calcium hydroxide reacts with nitric acid.

7. Answer the questions. (14 marks)

(a) (i) What does STP mean? What are the numerical values?

(ii) Write down the activity series.

(iii) The mass of 3.17g of chlorine gas occupies the volume of 1dm^3at STP. What is the relative molecular mass of chlorine gas? Show that one molecule of chlorine contains 2 atoms of chlorine? (Cl=35.5)

(b) What are the main types of oxides? Answer with suitable example.

Appendix C

Marking Scheme (Pretest)

1. (a) False

   (b) True

   (c) True

   (d) True

Each 1 mark x 4 = 4 marks

2. (a) 22.4 dm^3

   (b) decompose

   (c) oxidation

   (d) alkalis

Each 1 mark x 4 = 4 marks

3. (a) equal

   (b) Metals, Non-metals

   (c) normal salt

   (d) acidic

Each 1 mark x 4 = 4 marks

4.

List A	List B
(a) One molecule of oxygen	(ii) 2 atoms of oxygen
(b) Oxygen	(iv) diatomic molecule
(c) Neutral oxide	(iii) shows neither basic nor acidic oxide
(d) Water	(i) neutral to litmus

Each 1 mark x 4 = 4 marks

4. (a) (i) One mole of a substance

   One mole of a substance is the amount of that substance which contains the same number of particles (atoms, molecules, etc) as there are atoms in 12 g of ^{12}C. **1 mark**

   (ii) Molar volume of the gas

One mole of any gas occupies a volume of 22.4 dm^3 at STP. **1 mark**

(b) mass of oxygen = 32 g

Volume of oxygen = 22.4 dm^3 at STP

$$\text{Density of oxygen} = \frac{\text{mass of } O_2}{\text{volume of } O_2 \text{ at STP}}$$ **1 mark**

$$= \frac{32\text{ g}}{22.4\text{ dm}^3}$$

= 1.43 g dm^{-3} at STP **1 mark**

(c) CFCs are used in refrigerators and car air conditioner, and in foam packaging and insulation, and are used for cleaning computers and circuit boards.

2 marks

(d) Three classes of hydroxides

(i) basic hydroxides (e.g. NaOH or KOH)

(ii) amphoteric hydroxides (e.g. Zn $(OH)_2$ or Al $(OH)_{2)}$

(iii) acid hydroxides (e.g. $(HO)_2$ SO_2 or $HONO_2$) **2 marks**

Total = 8 marks

6. (a) (i) Relative molecular mass of H_2SO_4 = (2 x 1) + 32 + (4 x 16)

= 2 +32 + 64

= 98 **1 mark**

(ii) Relative molecular mass of SO_2 = 64

1 mole of SO_2 = 64 g **1 mark**

22.4 dm^3 at STP = 1 mole of SO_2

= 64 g **1 mark**

$$67.2\text{ dm}^3 = 64\text{g} \times \frac{67.2\text{dm}^3}{22.4\text{dm}^3}$$

= 192g **1 mark**

(b) (i) Ozone layer filters out most of the ultraviolet radiation in sunlight.**2 marks**

(ii) We can protect the ozone hole problem by banning the uses of CFCs and by substitution of CFCs with HCFCs, hydrochloro fluoro carbons, which cannot attack the ozone. **2 marks**

(c) (i) carbon dioxide + sodium oxide → sodium carbonate **1 mark**

$CO_2 + Na_2O \rightarrow Na_2CO_3$ **1 mark**

(ii) calcium hydroxide + nitric acid → calcium nitrate + water **1 mark**

$Ca(OH)_2 + 2HNO_3 \rightarrow Ca(NO_3)_2 + 2H_2O$ **1 mark**

Total = 12 marks

7. (a) (i) STP means Standard Temperature and Pressure. **1 mark**

Standard temperature = 0ºC or 273 K

Standard pressure = 760 mmHg or 1 atm **1 mark**

(ii) The activity series

K
Na
Ca
Mg
Al
Zn
Fe
Pb
H
Cu
Ag ↓

Electropositivity decreases from top to bottom. **2 marks**

7. (a) (iii) 1 dm^3 of chlorine at STP = 3.17 g

$$22.4\ dm^3 = 3.17g \times \frac{22.4dm^3}{1dm^3}$$

$$= 71\ g$$

Relative molecular mass of chlorine = 71 **1 mark**

$$\text{Number of chlorine atoms} = \frac{\text{Relative molecular mass}}{\text{Relative atomic mass}}$$

$$= \frac{71}{35.5}$$

$= 2$ atoms **2 marks**

One molecule of chlorine contains 2 atoms of chlorine.

(b) Six main types of oxides

(i)	Basic oxides	(e.g. K_2O or Na_2O)	
(ii)	Acidic oxides	(e.g. SO_2 or CO_2)	
(iii)	Amphoteric oxides	(e.g. ZnO or Al_2O_3)	
(iv)	Neutral oxides	(e.g. CO or N_2O)	
(v)	Peroxides	(e.g. BaO_2)	
(vi)	Compound oxides	(e.g. Pb_3O_4 or Fe_3O_4)	**7 marks**

Total = 14 marks

Appendix D

Item Analysis for Pretest

Number	Difficulty Index	Discrimination Index
1	0.87	0.08
2	0.7	0.08
3	0.79	0.08
4	1	0
5	0.49	0.41
6	0.6	0.27
7	0.74	0.16

The formula employed to calculate the difficulty index and discrimination index are as follows:

$$D_f = \frac{P_u + P_l}{2}$$

$$D_s = P_u - P_1$$

where, D_f = Difficulty index

D_s = Discrimination index

P_u = Portion of the upper 27 percent group who got the item right

P_l = Portion of the lower 27 percent group who got the item right

Note : The acceptable range of D_f and D_s are within 0.20 to 0.80 and 0.30 to 0.80.

Appendix E

Validation (Posttest)

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q&mBuD;^q&mrBuD;rsm;\ tawGUtBuHKt&þar;cGef;rsm;onf e0rwef; (Grade – 10) ausmif;om;^ausmif;olrsm;\ "mwkaA'qdkif&mwwfajrmufrIudkppfaq;&efqDavsmfrI ½Sd^r½Sd ESifhjyKjyif&efvdktyfygu yl;wGJygpm½GufwGif tBuHjyKay;yg&ef av;pm;pGmwifjy tultnD awmif;cHtyfygonf/

usrf;BuD;Muyfol

a'gufwmrMunfaqG

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oifjyenf;Xme

&efukefynma&;wuúodkvf

av;pm;rIjzifh

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tBuHjyKol\ udk,fa&;rSwfwrf;tusOf;

trnf	---------------------------------&mxl;
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ausmif;^Xme	---------------------------------
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pkpkaygif;vkyfouf	---------------------------------vkyfouf
(ynma&;^oifjyenf;Xme)	---------------------------------
"mwkaA'bmom&yfESifhywfoufaom	
tawGUtBuHKvkyfouf	---------------------------------

Questionnaire for Validation

(Posttest)

Grade (10) Chemistry Time Allowed (2) hours

1. Write TRUE or FALSE for each of the following statements. (4 marks)
   (a) An alkali is a basic hydroxide which is insoluble in water.
   (b) Sodium hydroxide is used in the manufacture of soap.
   (c) Carbon has four amorphous forms.
   (d) Carbon monoxide prevents the blood from carrying oxygen for use in the body.

2. Fill in the blanks with a suitable word or words. (4 marks)
   (a) The hydroxides of Al, Zn, and ….. are amphoteric.
   (b) The reaction between a basic oxide or hydroxide and an acid to form a salt and water is called ……
   (c) Diamond and graphite are the ….. allotropes of carbon.
   (d) Carbon dioxide is a tasteless gas and is used in fire ……

3. Select the correct word or words given in the brackets. (4 marks)
   (a) An alkali is (calcium hydroxide, copper (II) hydroxide, zinc hydroxide).
   (b) Sulphur dioxide reacts with cold water to produce (sulphuric acid, sulphurous acid, hydrogen sulphate).
   (c) In graphite, each carbon is surrounded by (two, three, four) other carbon atoms.
   (d) Wood is heated to make (charcoal, coke, carbon black) in the absence of air.

4. Match each of the items given in list A with the appropriate item given in list B. (4 marks)

List A	List B
(a) Carbon black	(i) a fuel in industry
(b) Coal	(ii) is found in nature

(c) Coke	(iii) a black powder
(d) Charcoal	(iv) a black porous solid

5. Answer the questions. (8 marks)

(a) Define (i) acid, (ii) base.

(b) (i) Give the name and formula of an acid salt.

(ii) Is copper (II) sulphate crystal a hydrated or anhydrous salt? Give reason for your answer.

(c) Name two allotropes of carbon. Describe the differences in density, colour, and opacity between them.

(d) Write one equation for the reaction between hydrogencarbonate and dilute acid.

6. Answer the questions. (12 marks)

(a) (i) Write down three properties of bases.

(ii) Define a normal salt with an example.

(b) How would you prepare the following?

(i) sodium sulphate from sodium carbonate

(ii) potassium sulphate from potassium hydroxide

(c) What are the three methods for the laboratory preparation of carbon monoxide gas?

A flat-bottomed flask is used in one of them. Why?

7. Answer the questions. (14 marks)

(a) (i) Define the term "Dissociation". Write the equations for the dissociation process of hydrochloric acid, sulphuric acid, and nitric acid.

(ii) How would you find the differences between the following acids and bases in your daily life?

citric acid, ethanoic acid , sulphuric acid, calcium oxide

(b) Summarize the greenhouse effect. How can you reduce the environmental problems? Give your opinion.

Suggestions

Appendix F

Question (Posttest)

Grade (10) Chemistry Time Allowed (2) hours

1. Write TRUE or FALSE for each of the following statements. (4 marks)

   (a) An alkali is a basic hydroxide which is insoluble in water.

   (b) Sodium hydroxide is used in the manufacture of soap.

   (c) Carbon has four amorphous forms.

   (d) Carbon monoxide prevents the blood from carrying oxygen for use in the body.

2. Fill in the blanks with a suitable word or words. (4 marks)

   (a) The hydroxides of Al, Zn, and ….. are amphoteric.

   (b) The reaction between a basic oxide or hydroxide and an acid to form a salt and water is called ……

   (c) Diamond and graphite are the ….. allotropes of carbon.

   (d) Carbon dioxide is a tasteless gas and is used in fire ……

3. Select the correct word or words given in the brackets. (4 marks)

   (a) An alkali is (calcium hydroxide, copper (II) hydroxide, zinc hydroxide).

   (b) Sulphur dioxide reacts with cold water to produce (sulphuric acid, sulphurous acid, hydrogen sulphate).

   (c) In graphite, each carbon is surrounded by (two, three, four) other carbon atoms.

   (d) Wood is heated to make (charcoal, coke, carbon black) in the absence of air.

4. Match each of the items given in list A with the appropriate item given in list B. (4 marks)

   List A List B

(a) Carbon black	(i) a fuel in industry
(b) Coal	(ii) is found in nature
(c) Coke	(iii) a black powder
(d) Charcoal	(iv) a black porous solid

5. Answer the questions. (8 marks)

(a) Define (i) acid, (ii) base.

(b) (i) Give the name and formula of an acid salt.

(ii) Is copper (II) sulphate crystal a hydrated or anhydrous salt? Give reason for your answer.

(c) Name two allotropes of carbon. Describe the differences in density, colour, and opacity between them.

(d) Write one equation for the reaction between hydrogencarbonate and dilute acid.

6. Answer the questions. (12 marks)

(a) (i) Write down three properties of bases.

(ii) Define a normal salt with an example.

(b) How would you prepare the following?

(i) sodium sulphate from sodium carbonate

(ii) potassium sulphate from potassium hydroxide

(c) What are the three methods for the laboratory preparation of carbon monoxide gas?

A flat-bottomed flask is used in one of them. Why?

7. Answer the questions. (14 marks)

(a) (i) Define the term "Dissociation". Write the equations for the dissociation process of hydrochloric acid, sulphuric acid, and nitric acid.

(ii) How would you find the differences between the following acids and bases in your daily life?

citric acid, ethanoic acid , sulphuric acid, calcium oxide

(b) Summarize the greenhouse effect. How can you reduce the environmental problems? Give your opinion.

Appendix G

Marking Scheme (Posttest)

1. (a) False
   (b) True
   (c) True
   (d) True

Each 1 mark x 4 = 4 marks

2. (a) Pb
   (b) sulphuric acid
   (c) three
   (d) charcoal

Each 1 mark x 4 = 4 marks

3. (a) equal
   (b) Metals, Non-metals
   (c) normal salt
   (d) acidic

Each 1 mark x 4 = 4 marks

4.

List A	List B
(a) One molecule of oxygen	(ii) 2 atoms of oxygen
(b) Oxygen	(iv) diatomic molecule
(c) Neutral oxide	(iii) shows neither basic nor acidic oxide

(d) Water (i) neutral to litmus

Each 1 mark x 4 = 4 marks

5. (a) (i) Acid

An acid is a compound which, when dissolved in water, produces hydrogen ions, H^+, as the only positive ion. **1 mark**

(ii) Base

A base is usually a metallic oxide or hydroxide and will react with an acid to form a salt and water only. **1 mark**

(b) (i) name of an acid salt = sodium hydrogen sulphate

formula = $NaHSO_4$ **1 mark**

(ii) copper (II) sulphate crystal is a hydrated salt, because it is a compound with water of crystallization. **1 mark**

(c) Two allotropes of carbon – diamond and graphite

Diamond

Density - 3.5 g cm^{-3}

Colour - colourless

Opacity - transparent **1 mark**

Graphite

Density - 2.3 g cm^{-3}

Colour - grey-black

Opacity - opaque **1 mark**

(d) sodium hydrogen carbonate + hydrochloric acid (dil) ⟶ sodium chloride + water + carbon dioxide

$$NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$$

2 marks

Total = 8 marks

(6) (a) (i) Three properties of bases

It turns red litmus blue.

It is soapy or slippery to the touch.

It reacts with acid to form a salt and water. **2 marks**

(ii) Normal salt

A normal salt is one which is made up of only a metallic radical, united with an acid radical. It contains neither replaceable hydrogen nor a hydroxyl group.

For example = Na_2CO_3 **2 marks**

(b) (i) sodium carbonate + sulphuric acid (dil) $\longrightarrow$ sodium sulphate + water + carbon dioxide

$Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO_2$ **2 marks**

(ii) potassium hydroxide + sulphuric acid (dil) $\longrightarrow$ potassium sulphate + water

$2KOH + H_2SO_4 \longrightarrow K_2SO_4 + 2H_2O$ **2 marks**

(c) Three methods for the laboratory preparation of carbon monoxide (CO) gas

Laboratory preparation of CO from methanoic acid

Laboratory preparation of CO from sodium methanoate

Laboratory preparation of CO from ethanedioic acid **3 marks**

Because it does not require heat. **1 mark**

Total = 12 marks

(vii) (a) (i) Dissociation

When an acid is dissolved in water, it splits up into electrically charged particles called ions. This process is known as dissociation.

1 mark

Hydrochloric acid $HCl \longrightarrow H^+ + Cl^-$

Sulphuric acid $H_2SO_4 \longrightarrow 2H^+ + SO_4^{2-}$

Nitric acid $HNO_3 \longrightarrow H^+ + NO_3^-$ **3 marks**

Citric acid - in fruit juice

Ethanoic acid - in vinegar

Sulphuric acid - in car batteries; used for making fertilizers **3 marks**

(b) The greenhouse effect

A layer of carbon dioxide and water vapour surrounds the earth. This layer reduces the amount of heat which the earth radiates into space. By burning hydrocarbon fuels, we pour carbon dioxide and water vapour into the atmosphere. The layer of carbon dioxide and water vapour is growing thicker. If it becomes too thick, the earth will warm up, and the ice caps can begin to melt. This blanketing by water vapour and carbon dioxide is called the greenhouse effect. **3 marks**

We can reduce the environmental problems including global warming by

- reducing the use of CFCs or telling not to use them,

- using new ways in the factories,

- growing the plants around us, and

- protecting the fire in the forests. **3 marks**

In my opinion, in order to be healthy and happy environment, I will grow the plants and ride a bicycle instead of using motor cycle to reduce CO_2. **1 mark**

Total = 14 marks

Appendix H

Item Analysis for Posttest

Number	Difficulty Index	Discrimination Index
1	0.54	0.25
2	0.62	0.25
3	0.70	0.08
4	0.41	0.16
5	0.39	0.21
6	0.41	0.44
7	0.13	0.31

The formula employed to calculate the difficulty index and discrimination index are as follows:

$$D_f = \frac{P_u + P_l}{2}$$

$$D_s = P_u - P_1$$

where, D_f = Difficulty index

D_s = Discrimination index

P_u = Portion of the upper 27 percent group who got the item right

P_l = Portion of the lower 27 percent group who got the item right

Note : The acceptable range of D_f and D_s are within 0.20 to 0.80 and 0.30 to 0.80.

Appendix I

Sample Procedures of Teaching Grade Ten Chemistry Students by Activity-based Learning

1. Standard - Grade (10)
2. Subject - Chemistry
3. Topic - Chapter (15)

   Carbon and its Compound
4. Subtopic - The Greenhouse Effect
5. Time Duration - 45 minutes
6. Instructional Objectives

   (a) General Objective

   - Be able to explain the greenhouse effect

   (b) Specific Objectives

   - Be able to write down the gases responsible for the greenhouse effect
   - Be able to summarize the greenhouse effect
   - Be able to prevent the environmental problems of the greenhouse effect
7. Teaching Materials - Textbook, Chalkboard, 26 Activity Cards of Greenhouse Effect, Figure showing the Process of Greenhouse Effect

8. Procedure

Table 1 Teaching Procedures for Grade Ten Chemistry Students by Activity-based Learning

Teacher Activity	Student Activity	Desired Learning Outcomes
(a) Statement of the Problem		
The teacher introduces the topic 'the greenhouse effect' and tells the objectives.	Students listen to teacher who begins the lesson.	Becomes aware of the lesson on the greenhouse effect. Keeps the objectives in mind.
(b) Learning Experiences		
The teacher brings (26) activity cards into classroom. The four titles included in those activity cards are (1) Causes of greenhouse effect, (2) Responsible gases for greenhouse effect, (3) Effects of greenhouse effect, and (4) Ways of preventing environment.		
The teacher discusses the greenhouse effect with	The students participate in question-answer strategy	Becomes interested and curious about the

students. Then, the teacher asks questions concerning the above four titles. **(c) Collection and Analysis of Information** Students are grouped. Each group has (5) students. The teacher discusses cooperative learning principles with students. They are (1) Positive interdependence, (2) Face-to-face interactions, (3) Individual accountability, (4) Interpersonal and small group skills, and (5) Processing. The teacher explains how to work with activity cards as follows. 'Match each title with its information.'	actively. The students cannot answer well. (30) students are divided into (6) small groups. The students understand the five principles. The students apply five principles to their activity to combine each title with information. They use prior knowledge	lesson. Becomes curious about the questions. Acquires social skills. Is able to collect and

He goes around classroom to check whether group members participate in activity or not. (d) **Generalization or Conclusion** Finally, the teacher invites a student from each group in front of the class to check title 1. After title 1, he invites another student from each group to check title 2. Similarly, title 3 and title 4 are done. The teacher concludes the lesson as follows. There are six causes in title 1. Causes of greenhouse effect. There are four gases in title 2. Responsible gases for greenhouse effect. There are six effects in title 3. Effects of greenhouse effect. There are six ways in title 4. Ways of preventing environment.	and decide whether they are right or not. Four students from four groups come out with title 1. Then, students with title 2, 3 and 4 come out. The students are very happy because their answers are correct.	analyze the information. Combines and connects experiences. Realizes the applicability of skills and understands all the lessons taught. Is able to acquire academic skills.

Appendix J

Activity Record

Activity 1. Causes of the Greenhouse Effect

(1) --.

(2) --.

(3) --.

(4) --.

(5) --.

(6) --.

Activity 2. Responsible Gases for the Greenhouse Effect

(1) --.

(2) --.

(3) --.

(4) --.

Activity 3. Effects of the Greenhouse Effect

(1) --.

(2) --.

(3) --.

(4) --.

(5) --.

(6) --.

Activity 4. Ways of Preventing Environment

(1) --.

(2) --.

(3) --.

(4) --.

(5) --.

(6) --.

Teaching Materials ---

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Each Group Member's Suggestion ---.

Bibliography

Alessi, S. M., & Trollip, S. R. (2001). *Multimedia for Learning: Methods and Development* (3rd ed.). Boston: A Pearson Education Company.

Arends, R. I. (2007). *Learning to Teach* (7th ed.). New York: McGraw-Hill.

Armstrong, D. G., Henson, K. T., & Savage, T. V. (1989). *Education: An Introduction* (3rd ed.). New York: Macmillan Publishing Company.

Basic Education Curriculum, Syllabus and Textbook Committee. (2011). *Chemistry. Grade Ten.* Myanmar: Aung San Printing Office.

Becker, W. C. (1986). *Applied Psychology for Teachers, A Behavioral Cognitive Approach*. USA: Science Research Associates, Inc.

Beeghly, D. G., & Prudhoe, C. M. (2007). *Litlinks: Activities for Connected Learning in Elementary Classrooms*. New York: McGraw-Hill, Inc.

Berger, E. H. (1987). *Parents as Partners in Education* (2nd ed.). Columbus: A Bell and Howell Information Company.

Bloom, B. S. (1956). *Taxonomy of Educational Objectives: The Classification of Educational Goals*. New York: David Makay.

Collette, A. T., & Chiappetta, E. L. (1989). *Science Instruction in the Middle and Secondary Schools* (2nd ed.). Columbus: Merrill Publishing Company.

Crawford, M. L. (2001). *Teaching Contextually*. Retrieved October 16, 2013, from http://www.cord.org/uploadedfiles/Teaching%20Contextually%20%28Crawford%29.pdf

Cruickshank, D., Metcalf, K. K., & Jenkins, D. B. (1999). *The Act of Teaching* (2nd ed.). Columbus: McGraw-Hill, Inc.

Dayal, D., Bhatt, R., & Ray, B. (2009). *Modern Methods of Teaching Chemistry*. New Delhi: A P H Publishing Corporation.

Department of Methodology. AY (2013-2014). *General Methodology*: *B.Ed Third Year, First Semester*. Yangon: Yangon Institute of Education.

Dewey, J. (1916). *Democracy and Education*. New York: Dover Publications, Inc.

Duvarci, D. (2010). *Activity-based Chemistry Teaching: A Case of "Elements and Compounds".* Retrieved October 16, 2013, from http://www.sciencedirect.com/ science/article/pii/S1877042810004027

Fetsco, T., & McClure, J. (2005). *Educational Psychology. An Integrated Approach to Classroom Decisions*. Boston: Pearson Education, Inc.

Gallagher, J. J. (2007). *Teaching Science for Understanding*: *A Practical Guide for Middle and High School Teachers.* New Jersey: Pearson Education, Inc.

Hammond, D. L. , & Bransford, J. (2005). *Preparing Teachers for a Changing World*. San Francisco: John Wiley & Sons, Inc.

Hariharan, P. (2011). *Effectiveness of Activity-based Learning Methodology for Elementary School Education.* Retrieved October 16, 2013, from http://www.ukfiet.org/sites/all/docs/Paper%20by%20S.%20Anandalakshmy.pdf

Horsley, S. L., Siles, K. E., Mundry, S., Love, N., & Hewson, P. K. (2010*). Designing Professional Development Teachers of Science and Mathematics* (3rd ed.). New Delhi: Corwin A Sage Company.

Htoo Htoo Aung, Dr. (2011). *NFPE: A Helping Hand*. Yangon: Shwe Minn Tha Press.

Jaconben, D., Eggen, P., Kauchak, D., & Dalaney, C. (1985). *Methods for Teaching: A Skills Approach* (2nd ed.*)*. Columbus: A Bell & Howell Company.

Joyce, B., & Weil, M. (1980). *Models of Teaching* (2nd ed.). New Jersey: Prentice-Hall, Inc.

Kask, U., & Rawn, J. D. (1993). *General Chemistry*. London: Wm.C. Brown Communications, Inc.

Khan, M., Niaz Muhammad, Dr., Ahmed, M., Saeed, F., & Khan, S. A. (2012). *Impact of Activity-based Teaching on Students' Academic Achievements in Physics at Secondary Level*. Retrieved October 16, 2013, from http://www.savap.org.pk/journals/ARlnt./Vol.3%281%29/2012%283.119%29.pdf

Lombardi, M. M. (2007). *Authentic Learning for the 21st Century: An Overview.* Retrieved October 8, 2013, from http://net.educause.edu/ir/library/pdf/eli3009.pdf

McCombs, B. L., & Whisler, J. S. (1997). *The Learner-centered Classroom and School: Strategies for Increasing Student Motivation and Achievement*. San Francisco: John Wiley & Sons, Inc.

Meece, J. L. (2002). *Child & Adolescent Development for Educators* (2nd ed.). New York: McGraw- Hill.

Moon, B., & Mayes, A. S. (1996). *Teaching and Learning in the Secondary School*. London and New York: Open University.

Moore, K. D. (2007). *Classroom Teaching Skills* (6th ed.). New York: McGraw-Hill, Inc.

Morrison, G. S. (1988). *Early Childhood Education Today* (4th ed.). Columbus: A Bell and Howell Information Company.

Newburg, N. F. (1971). *The Teaching of Chemistry in Tropical Secondary Schools*. London: Butter & Tanner.

Passer, M. W., & Smith, R, E. (2007). *Psychology: The Science of Mind and Behavior* (3rd ed.). New York: McGraw-Hill, Inc.

Rao, V. K. (2009). *Educational Technology*. New Delhi: A P H Publishing Corporation.

Ray, B. (2009). *Modern Methods of Teaching Chemistry*. New Delhi: A P H Publishing Corporation.

Rowntree, D. (1982). *A Dictionary of Education*. New Jersey: Barnes & Noble Books-Totowa.

Sadker, M. P., & Sadker, D. M. (2005). *Teachers, Schools and Society* (7th ed.). New York: McGraw-Hill, Inc.

Salend, S. J. (2001). *Using an Activities-based Approach to Teach Science to Students with Disabilities*. Retrieved October 8, 2013, from www.catea. gatech.edu / scitrain/kb/ FullText-Articles /Salend-pdf

Sang, M. S. (2003). *An Education Course for K.P.L.I, Theme 1.* Subang Jaya: Kumpulan Budiman Sdn Bhd.

Sang, M. S. (2003). *An Education Course for K.P.L.I, Theme 2.* Subang Jaya: Kumpulan Budiman Sdn Bhd.

Schunk, D. H. (2004). *Learning Theories: An Educational Perspective* (4th ed.). Upper Saddle River, New Jersey: Pearson Prentice Hall.

Sevilla, C. G. (1992). *Research Methods*. Manila: Rex Book Store.

Singh, Y. K. (2009). *Teaching Practice: Lesson Planning*. New Delhi: APH Publishing Corporation.

Sirhan, G. (2007). *Learning Difficulties in Chemistry*: *An Overview*. Retrieved October 8, 2013, from http:// www. tused. org.

Slavin, R. E. (2003). *Educational Psychology: Theory and Practice* (7th ed.). New York: Pearson Education, Inc.

StoBlein, M. (2009). *Activity-based Learning Experiences in Quantitative Research Methodology for Young Scholars-Course Design and Effectiveness*. Retrieved October 8, 2013 from www.pomsmeetings.org/ConfPapers/011/011-0782.pdf

Sunita, G. H. (2012). *A Comparative Study of Piaget's and Vygotsky's Cognitive Development Theory*. Lokavishkar International E-Journal, ISSN 2277-727X, Vol-1, Issue-II, Apr-May-June 2012. Retrieved November 4, 2013, from www.liirjj.org.

Superfine, W. (1999). *Why Use Activity-based Learning in the Young Learner Classroom?* Retrieved October 16, 2013, from http://www.esecs.ipleiria.pt/f1412.1.pdf

Trilling, B., & Fadal, C. (2009). *21st Century Skills, Learning for Life in Our Times*. San Francisco: Jossey-Bass.

Unesco. (1984). *Teaching School Chemistry*. London: Imprimerie Floch, Mayenne.

Woolfolk, A. E. (1990). *Educational Psychology* (4th ed.). London: Prentice-Hall, Inc.