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USING COMPUTER ANIMATIONS TO ENHANCE STUDENTS' UNDERSTANDING OF ACID STRENGTH

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DECEMBER, 2015

DECLARATION

CANDIDATE'S DECLARATION

I, VICTORIA ATALATA ABANGA declare that, this dissertation, with the exception of quotations and references contained in published works which have all been identified and acknowledged, is entirely my own original work and it has not been submitted, either in part or whole for another degree elsewhere.

SIGNATURE: ……………………………………………………

DATE : ……………………………………………………..

SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this research work was supervised in accordance with the guidelines for supervision of dissertation as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: DR. (MRS.) RUBY HANSON

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DATE : ………………………………………………

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DEDICATION

This dissertation is dedicated to Pastor Ben Asore Anyorigi, my husband and my children for their prayer support which have led to the success of this dissertation.

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ABSTRACT

The study aimed at improving students" understanding of the concept of acid strength in Kusanaba Senior High School through the use of computer animations. A practical approach to instruction was adopted while using computer animations as a corrective tool to students" misunderstanding of the concept under study. The fact that the sample consisted of two different classes taught by the Researcher, each having different subject/time schedules and partly because it was not disclosed to subjects that this particular topic was under study, there was no observable between group interactions that could in any way influence the outcome of the study. One class was taught through computer animations while the other class was taught through the traditional method. Data were collected from the two intact classes comprising 100 third year elective agriculture students during two classroom lessons by means of a pre-intervention test. Intervention activities, computer animated activities were designed and used in teaching the experimental group. The control group received their instructions through teacher illustration. These were followed by a post- intervention test. The results were analyzed by means of descriptive statistics specifically the mean scores and the standard deviations. From the study, it was found that the animation method proved to have enhanced the performance of the students than that of the traditional method. This was indicated by a significant average mean difference of 5.4 in a post- test exercise. The implications of the results for the teaching and learning of acid strength are that teaching through animations helps students to develop conceptual understanding, and promote meaningful learning by creating dynamic mental models of particulate phenomena that students find difficult to understand. It is therefore recommended that more of computer animated activities should be incorporated in teaching subsequent lessons in chemistry to fully ascertain the effectiveness of using animation in the

teaching and learning of chemistry.

CHAPTER ONE

INTRODUCTION

1.0 Overview

The chapter entails the background to the study, statement of the problem, objective of the study, specific objectives, research questions, significance of the study, limitation, delimitation of the study, and abbreviation.

1.1 Background to the Study

Computer animated visualizations are scientific tools which help teachers to convey abstract scientific concepts in chemistry. They enable a teacher to show both chemical structures and processes as they truly are perceived in real form and time. In times past chemical structures and processes have been taught in abstract. Through this abstraction, students are expected to visualize structures of elements and to view them as being involved in chemical processes. They are expected to illustrate them graphically or in symbolic form in microscopic and macroscopic forms. These diverse representational levels pose a challenge to learners. Thus, the proposed trend in helping students to conceptualize such chemical processes is to show graphical visuals of what goes on within reacting species and their probable products. When learners perceive and comprehend such visualizations, they enhance their academic performances especially in molecular chemistry including acid- base concepts (Falvo, 2008). According to Falvo, students learn molecular chemistry concepts and relations by attending to, seeing, and understanding all the associated elements and the ways that they change and evolve during the process. Instructional developers should therefore seek to design visualizations which allow students to learn critical concepts as well as the relationships between these concepts. Animations allow students to represent observed phenomena as models in their minds. It also helps them to connect between the macro, micro and the molecular levels of chemistry. Chemistry is one of the most important subjects in the field of science. This field includes so many complicated and abstract concepts to learn at all levels of schooling. Knowledge in chemistry is required for the understanding of nature and its conversions into suitable forms to meet daily needs and so it is an important subject, regardless what others think about it being a difficult discipline to learn. Interestingly, there has been a global emphasis on science education, chemistry inclusive. Consequently, stakeholders of education in Ghana have been urged to provide not only adequate facilities for education but also to make quality a primary focus, especially in the area of science and technology (MEYS, 2004).

Over the years, the Ministry of Education, Science and Sports (MOESS) in Ghana and Ghana Education Service (GES) have made several attempts to reform teacher education to enhance the quality of teaching and learning of science and mathematics in the basic schools in Ghana (GES, 2007). This could partly be because of the relevance of science in everyday life as well as in global culture (Dahsah & Coll, 2007, GES, 2007). In line with the new reforms, this study explored the use of different activities mediated by computer animations to promote the understanding of the acid strength concept at Kusanaba SHS. This study also investigated whether the educational setting under which the experiences were obtained and the social influences on the students as well as the teaching philosophy of the Researcher could have any impact on the intervention. The Agriculture Department of Kusanaba SHS has always recorded the worse chemistry WASSCE examination results in the Municipality since the introduction of chemistry in 2012 as is indicated in Appendix A. Although many factors come into play in students‟ failure, recent researches have proved that the difficulty of students in relating the different (micro, macro, and molecular) levels of chemistry knowledge is a hindrance to their understanding.

Truly, a careful glance at the Kusanaba SHS agriculture class students‟ performance in class tests, exercises and general class interaction assessments is indicative that chemistry in general and the acid strength concept in particular is a threat to students‟ performances. The inability of students to fully understand the acid strength concept jeopardizes their ability to deal with problems on acidic and alkaline solutions and their related concepts.

1.2 Problem Statement

Students at the Kusanaba S.H.S perform poorly in chemistry in general and specifically in the classification of acidic and alkaline solutions based on strength and amount of solute in solution. This became evident when about 80% of students performed poorly in a test on acid strength conducted by the Researcher. It was observed that, most students had memorized definitions without any conceptual understanding of the term „acid strength‟. It was against this background that, the study was conducted so as to help alleviate students‟ problems in dealing with exercises on acid strength.

1.3 Objective of the Study

This study was an action research which aimed at enhancing the understanding and performance of Form Three (3) General Agriculture Science students of Kusanaba S.H.S in the concept of acid strength and its application in stoichiometric problems through the use of computer animations.

1.4 Specific Objectives

The objectives of this study were to:

(i) Help determine misunderstandings held by Form Three (3) General Agriculture Science students of Kusanaba S.H.S about acid strength through a pre- test exercise.

(ii) Provide Form Three (3) General Agriculture Science students of Kusanaba S.H.S with the opportunity to do simple activities on acid strength.

(iii) Use animations to help enhance performances of Form Three (3) General Agriculture Science students of Kusanaba S.H.S in acid strength problems.

1.5 Research Questions

This study basically addressed the following research questions:

1. What conceptions would Form Three (3) General Agriculture Science students of Kusanaba S.H.S have about the concept acid strength?

2. What aspects of animations would enhance the teaching and learning of acid strength at Kusanaba S.H.S?

3. What types of concepts would Form Three (3) General Agriculture Science students of Kusanaba S.H.S demonstrate after their use of or interaction with animations?

1.6 Significance of the Study

The findings of this study can help educational planners at the Ministry of Education in the formulation and implementation of policies as well as decisions on the teaching of acid strength in the chemistry syllabus.

The findings can also serve as an eye opener for curriculum developers to stress on the use of technological tools such as computer animations in teaching some of the topics that are considered as abstract to teach for conceptual understanding.

It can also help educational authorities in Kusanaba S.H.S. to become aware of some of the problems in the general agriculture department, which contribute to the poor performance of chemistry students.

Finally, the study can serve as a wakeup call on instructors and teachers of chemistry at Kusanaba SHS to rise and integrate technology into their teaching of content knowledge by using animations to make lessons more interesting and more understandable for learners. This could help in building students" interest in chemistry and in enhancing attempts at enabling conceptual changes.

1.7 Delimitation of the Study

Delimitations, according to Simon (2011), are characteristics that limit the scope and define the boundaries of a study. The focus group discussion method of interview employed for the study could not provide responses to items used as desired. This was glary when some students were prevented by their colleagues from giving out certain responses. To them, the subject teachers would feel disappointed if they should get to hear such responses. An example of such an obstruction to obtaining authentic information was when questions concerning the use of computer aided programs in teaching chemistry were posed to students.

1.8 Limitation of the Study

Limitations in educational research are defined as potential weaknesses in one‟s study that are not within their control. Simon (2011). Ideally, this study should have included other schools in the Bawku - West District of the Upper East region to fully ascertain the effectiveness of the intervention as stated in the findings. Unfortunately, due to funding coupled with time constraints, the Researcher was compelled to carry out the study on only two classes students in only one Senior High School.

1.9 Abbreviations

K.S.H.S-------------------Kusanaba Senior High School

WASSCE---------------West African Senior Secondary School Certificate Examination

S.H.S/SHS-------------Senior High School

ICT ---------------Information and Communication Technology

Exam------------Examination

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

In this chapter, the available literature in relation to the use of computer animations will be discussed. Journals, books and articles on the subject matter and the work of other researchers in the area of this study will be reviewed. The areas of focus are as follows:

- The theoretical framework underpinning the study.
- Animations as an educational tool.
- The skills acquired through the use of animated- mediated tools.
- The impact of computer animations on conceptual understanding of students.
- Using animations to enhance the understanding of acid strength concept.
- The role of animations in conceptual change.

2.1 Theoretical Framework Underpinning the Study

Weiss, Knowlton, and Morrison (2002, as cited in Chang, Quintana, & Krajcik, 2007) suggest that theoretical foundation for the use of instructional animations have not been firmly established. Meanwhile, Mayer and Moreno (2002) view animation as a subset of visual representations. To them, visual representations are hypothesized to have superior effects on learning because they are more likely to be coded in two channels than verbal information. Chang *et al*. (2007) again cited that another cognitive model, the sensory-semantic model, suggests the superiority of visual representations over textual representations because visual representations stimulate activation of meaning directly whereas textual representations require phonemic analysis before activation of meaning. However, animation has the capability of simulating movement and trajectory in ways that static visual representations cannot.

The theory that supports the use of static visual representations might not fully describe the benefits of animation, leaving questions about the cognitive and social processes that animation may foster. The finding of Chang *et al*., (2007), however suggests that a perspective from social practice could be applied to instructional animation. In their view, practice constitutes one important component in learning environments. It refers to social activities involving actions of participants, and interactions between participants and resources (Barab, Hay, Barnett, & Squire, 2001). Interactions in practices of technology-rich learning environments include two types: the informatics (e.g., teacher-technology-student) and the normal social interactions such as that between teacher-student or student-student (Roschelle, 2003). Tversky (2001, as cited in Falvo, 2008) states that visualizations and symbols argument human cognitive capacities and help to convey concepts and information.

2.2 Animation as an Educational Tool

Animation is a tool that allows learners to make molecular models about chemical phenomena. Animations are more realistic for showing change; they can demonstrate in action the systems to be taught and can show change in time, they are thought to be natural and effective for conveying change in time (Kim, Yoon, Whang, Tversky, & Morrison, 2007). According to Chang, Quintana and Krajcik (2007) animations are effective aids for teaching concepts that involve motion in the molecular level. Students make mental models based on observations that are personal, qualitative and often in complement. The use of dynamic visual models and visual representations of chemical processes helps students to develop conceptual understanding, and promote meaningful learning by creating dynamic mental models of particulate phenomena. Tasker (2004) also stated that, like many other educational tools, animations need to be integrated into larger learning environments.

The move for the use of mental models during educational instructions to explain abstract concepts in chemistry started long ago. However, learning these concepts without reference to the particulate nature of matter can cause learning difficulties. Students find it difficult to imagine what would be happening to reacting species at the microscopic level. Observations of macroscopic phenomena such as a change in color or the generation of gas products sometimes reveal little about whether a phenomenon involves a chemical or physical change. In Chang, *et al*., (2007), Ebenezer (2001) is said to have found that computer models permit students to link their microscopic explanations of chemical phenomena with their macroscopic observations as students can visualize microscopic processes in chemistry, and subsequently better understanding of chemical knowledge. Chang, *et al*., (2007) also reiterated that Treagust and Chittleborough (2001) have discussed that the explanatory power of chemistry is at the molecular or atomic level, and so researchers have suggested that instruction which focuses on the molecular level would help students to develop adequate understanding of chemistry concepts and principles.

However, Tasker and Dalton (2006) suggest that molecular-level animations could be compelling and effective learning resources, but then they must be designed and presented with great care to encourage students to focus on the intended „key features‟, and to avoid generating or reinforcing misconceptions.

2.3 Skills acquired through the use of animated- mediated tools

Aesthetic, mental picture construction, cognitive interpretations of mental models and articulation of molecular fragments skills are some of the achievements gained by students through the use of animations. A model, as described by Gilbert, Boulter and Elmer (2000), is a representation of a phenomenon, an object, or idea. Tregidgo and Ratcliffe (2000) also described a model in science as the outcome of representing an object, phenomenon or idea with a more familiar one. Chemistry as a discipline is dominated by mental models (Coll & Tayler, 2002), which often are difficult for students to conceptualize. Buckley and Boulter (2000) viewed mental models as internal and cognitive representations. They are psychological representations of real or imaginary situations. They occur in a persons‟ mind as that person perceives and conceptualizes the situations happening in the world (Franco & Colinvaux, 2000).

Computer animation activities that demonstrate the dynamic processes allow students to be more interactive, learn from trial and error, and repeat their trial over and over-none of which were possible with the illustration activity (Marbach-Ad, *et al*., 2008). With animated depictions, information about the changes involved in chemical processes is available to be read straight from the display without the learner needing to perform mental animation. Nevertheless, the required image is accepted and stored in the learner‟s cognitive structure. With computer animation programs, students may build their own appropriate representations and use them to conduct higher-order thinking such as reasoning and interpretation (Chang & Quintana, 2006). Instructor-guided animations facilitate students' learning of chemistry, most probably by allowing students to visualize chemical reactions at the microscopic level and to create imaginative representations of those reactions in other forms. It seems that animations should be ideal for presenting dynamic contents like chemistry topics.

2.4 The Impact of Computer Animations on Conceptual Understanding of Students

Alternative concepts, which include perceptions, ideas, beliefs and everyday knowledge constructed by students as a result of prior experiences which do not match the generally accepted scientific concepts, ideas and beliefs may hinder the formation of scientific concepts through instructions as is identified in many research studies. According to Kearney and Treagust, (2001) and Kearney, (2004) as reiterated in Kala, Yaman and Ayas (2012), students come to classes with their own ideas related to the natural world. Instructors should be aware of their students‟ previous knowledge in order to plan their subsequent learning experiences, which in turn help to facilitate meaningful learning. Tasker (2004) also stated that instructors should focus attention on students‟ prior knowledge while drawing students‟ attention to the key features and functions portrayed in the animation. Effective animations are segmented and offer features such as pause and replay buttons to enable students to work on portions of activities that require redress.

Additionally, increasing the level of interactivity of animations stimulates engagement and motivation of learners (Lowe 2004). Kala, Yaman and Ayas (2012) conducted a study to investigate high school students‟ conceptions and misconceptions about P^{H}– P^{OH} and the strength of acids, as well as how this concept was constructed in their minds at the micro and macro levels. The results of the study revealed that majority of the students had misconceptions related to these three concepts. The students had a number of common misconceptions concerning the concepts of acids and bases. Kala, Yaman and Ayas (2012) also reiterated what Sheppard (2006) stated, that high school students in a study sample described pH as a measurement of strength and understood that more acidic solutions had a lower P^H. Boz (2009) notes that a majority of student teachers related acid strength to the hydrogen ion concentration, even though they were not aware of the differences between the concentration and the strength of acids.

Lin, Chiu and Liang (2004) also reported that high school students in Taiwan believed that the strength of an acid was related to the number of hydrogen atoms in the molecule formula. Additionally, Pınarbaşı (2007) revealed that Turkish undergraduate students had some misconceptions, such as, „the pH of an acid solution that is excessively diluted could be over 7‟. Thus, using animations of apparent real situations would be beneficial for concept formation among students who are in the formal operational stage but reason as children in concrete operational stages.

Animations are said to have diverse impact on the transformation of students‟ alternative concepts and conceptual change. Weiss, Knowlton, and Morrison (2002) discussed five functions of instructional animation, including:

(1) Cosmetic functions that make instruction attractive to learners,

(2) Attention gaining functions that signal salient points of a topic,

(3) Motivation functions that provide feedback to reinforce correct responses,

(4) Presentation functions that provide concrete reference and a visual context for ideas, and

(5) Clarification functions that clarify relationships through visual means.

As pointed out by Ploetzner, Lippitsch, Galmbacher, Heuer, and Scherrer, (2009); Sweller (2005); Tezcan and Yılmaz, (2003); Vermaat, Kramers-Pals, and Schank, (2004), briskness in animations reifies comprehension of abstract topics. Aksoy, (2012) indicated that animation technique enables higher academic achievement in comparison to traditional teaching method. Aksoy (2012) researched on the effect of animation technique on academic achievement of students in the "Human and Environment" unit lectured as part of the Science and Technology course of the seventh grade in primary education. The sample of the study consisted of 58 students attending to the 7th grade of Erzurum MEB Yildizkent IMKB primary school under two different classes during the 2011- 2012 academic year. While the lectures in the class designated as the animation group were given with animation technique, in the class designated as the control group, power point presentations was utilized along with the traditional teaching methods.

According to their findings, it was concluded that the animation technique was more effective than the traditional teaching methods in terms of enhancing students" achievement. Sanger, Brecheisen, and Hynek (2001), also found that college students who viewed animations of diffusion of perfume molecules and osmosis of water molecules had better understanding of random and constant movement of particles than the students who did not view the animations. Similarly, a study comparing student responses to a prediction question before and after viewing animation found that students did learn a lot and were able to make favorable predictions from viewing animations (Hegarty, Kriz, & Cate, 2003).

However, Chang, Quintana, and Krajcik (2007) pointed out that the effect of animation may not be significant when compared to other media such as static visuals. This according to Chang et al., (2007), is because animations are reported by Hegarty et al., (2003) and Lewalter (2003) to have no superior effect over static visuals. Hegarty et al., (2003) viewed that students who received static visuals in their study were able to construct a dynamic mental model on their own, thus viewing that an external animation was not essential to students‟ learning. Chang et al., (2007) also suggest that one important factor that influences the impact of animation is students‟ prior knowledge or ability.

Similarly, Falvo (2008) cited the following as reports on negative impact of using animations in teaching: (1) Historical problems in the use of animations for teaching a wide range of topics were detected by Martin and Tversky (2003) in a study that they conducted. They asserted that animations could mislead learning causing misunderstanding and misconceptions. Viewers often interpret movements of forms and figures in animation as having causality, agency, and even intention (2) Learners assume that colors and the shapes of animations reflect the actual reality of the represented items when often the shapes and colors are either symbolic or an idealization of time and space relations. (3) The molecules are symbolized by tumbling balls of different colors coming apart and coming together. Students see these balls as pushing others so they would join or adhere (Tasker, 2004) such as demonstrated in the figure below:

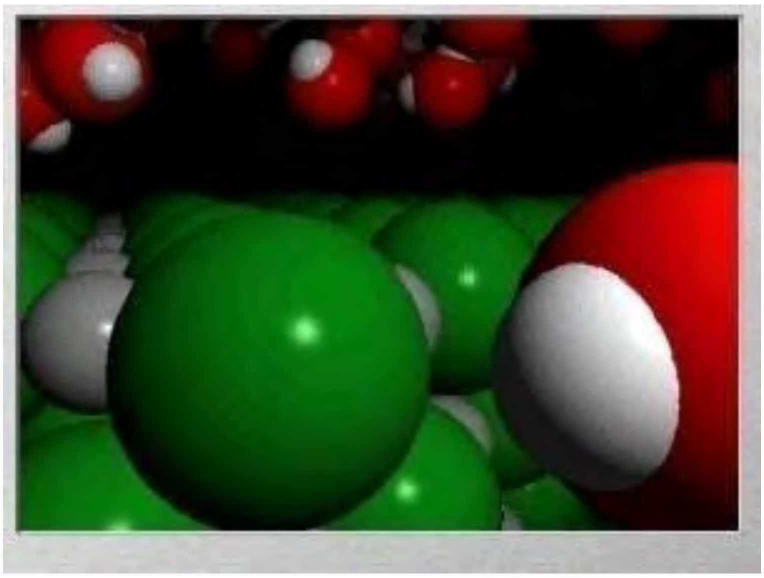

Figure 1: Image of Molecules from Salt Dissolving in Water

Additionally, Kim, Yoon, Whang, Tversky & Morrison, (2007) indicated that animations are often complex, and novices may not know which are the important features to attend to and process in their minds. According to them, learners may be so overwhelmed by the complexity that they give up and regard the animations passively rather than actively. Thus it is possible that animations may distract attention and interfere with deeper processing, therefore affecting comprehension negatively.

Lowe, (2003, 2004) pointed out that recent fine-grained studies indicate that the reasons why animations can be much less educationally effective than expected may lie in the way learners process the presented information. Lowe (2004) revealed that two distinct types of problems have been suggested: overwhelming and underwhelming (Lowe & Schnotz, in press). According to Lowe (2004), the first of these is thought to arise if presentational characteristics of the animation are such that the learner is unable to process the available information effectively under the prevailing conditions. For example, if the animation presents a complex set of information very rapidly, the learner may be overwhelmed by the flux of information and so be unable to keep pace with its delivery. Thus, there is a mismatch between the way in which the animation delivers information on one hand, and the learner's capacity to process it effectively on the other.

Lowe (2004) further explained that, underwhelming can be thought of as the converse of overwhelming: the animation leads to the learner being insufficiently engaged so that the available information is under-processed. To Lowe (2004), because animations can provide a direct depiction of the changes involved in a dynamic system, learners need do no more than observe these dynamics as they are portrayed. There is no need to carry out the intensive mental manipulations required for a static depiction of the same situation. It may be that by making change processes directly visible, the explicit external depiction provided by animations can give learners a false impression that they understand what is going on. However, students with higher cognitive capabilities are likely to be able to fulfill the demands required for understanding the subject matter without external support for mental simulation. For these students, animation can save them from having to perform beneficial learning-relevant cognitive processes on their own (Schnotz & Rasch, in press).

Mayer (2001) developed a research- based cognitive theory of multimedia learning which is found in the earlier work by other researchers. She conducted many studies of animations and diagrams that concluded that there are dual channels for cognitive processing of information. For example, when we see and hear something at the same time our mind coordinates both these channels. This is the case with all our senses, but it is much more prevalent with vision and hearing. Mayer found that words and pictures should be used simultaneously and should be presented close to each other in space.

Additionally, aesthetic and attractiveness of animated particles influences students" attitude towards using animations (Lidwell, Holden & Butler 2003). According to Lidwell, Holden and Butler (2003), when learners find an interface to be attractive and aesthetic, they tend to perceive the system as being effective. Addressing these perceptions helps learners to use animations more easily and more readily.

Yang and Andre (2003) assessed the impact of computer animations that illustrated chemical reactions that occur inside a battery (electrochemistry) on students in a college chemistry course. The subjects were divided into a Computer Animation Group (CAG) who received the dynamic visualization while the second group, the Still Diagrams Group (SDG) received the same lecture but still diagrams replaced the dynamic animations. The analysis on posttest results showed the significant effect of the treatment. Animations, with parallel verbal narration provided by an instructor, allowed students to visually follow the movement of ions and electrons and thereby created a better understanding of the electrochemical processes.

A study was also conducted by Dasdemir, Doymu and Karako (2008) to determine the effect of computer animations in teaching acid and base topics in chemistry and technology courses on the academic performance of primary school students and their opinions. The research was of a quasi-experimental design. The animation group was taught by computer animations in acids and bases concepts while the control group was taught by the traditional method in same topic. After an examination, findings showed that the mean scores of the animation group test significantly were better than the control group. Also, the animation group had positive opinions about teaching with the help of the animation instructional method. Ozmen, Demirciolu and Demircio (2009) determined the effect of conceptual change texts accompanied with computer animations on 11^{th} grade students' understanding and alternative conceptions related to chemical bonding. Students were divided into two groups as experimental group and comparison group and involved in a quasi-experimental design by pre-test-post-test. The result showed that the experimental group had significantly better understanding on chemical bonding than the comparison group. Their conclusion was that, conceptual change texts accompanied with animations, decreased alternative conceptions or misunderstanding in the experimental group.

Doymus, Simsek,and Karacop (2009) investigated the effects of computer animations and cooperative learning on students' comprehension of chemistry topics at the macro, micro, and symbolic levels. University students enrolled in three classes of the general chemistry course as cooperative group animation group and control group. Their achievements were evaluated in an experimental design by post-test scores. The result showed that students in the animation and cooperative groups had significantly better results than the traditional group in microscopic level representations. There were no significant differences in terms of understanding at the non-micro level (macro and symbolic). The average mean scores of the animation group were higher than those of the cooperative group. The maximum efficiency was achieved when both computer animations and cooperative learning methods were used.

Akpnar and Ergin (2007) also studied the effect of computer animations accompanied with experiments over traditionally designed instruction in a 6^{th} grade students' physics achievement and attitudes toward science. The study was carried out as a quasi-experimental design by pre-test/post-test. Analyses of findings show that using interactive computer animation accompanied with real science experiments was significantly more effective in enhancing students' achievement as compared to using only real science experiments in primary science course. Also he showed that the attitudes of the experimental group toward science as a school subject became more positive than those of the control group after treatment.

Ebenezer (2001) carried out a research into a hypermedia environment to explore and negotiate students‟ conceptions through the animation of the „solution process of table salt‟ with 11th grade students. The data concerning students' understandings and negotiation of meanings were collected through HyperCard. The HyperCard is an application program and programming tool for Apple Macintosh and Apple IIGS computers that was among the first successful hypermedia systems before the World Wide Web. In Ebenezer‟s study, animations in the hypermedia environment enabled students to visualize how melting differs from dissolving, how ions are formed, and how hydration took place. They were able to write the corresponding ionic equations for the various concepts and activities. It is therefore evident that animation could be used to explore, negotiate, and assess students' conceptions of the sub microscopic aspects of solution chemistry.

Marbach, Rotbain and Stavy (2008) studied the impact of using dynamic animations or illustration activities on students' understanding of dynamic processes (transcription translation and DNA replication) versus students' understanding of static configurations (the structure of DNA and RNA molecules). High school students from eleventh- and twelfth-grade classrooms were divided into a control group that was taught in the traditional lecture format, and two experimental groups that received instructions that integrated a computer animation or illustration activities. Results of the study showed that the computer animation by prompting the formation of dynamic mental models was significantly more effective than the illustration activity. The utilizing illustration activities can still improve students' achievement in comparison to traditional instruction. The paper however remarked that based on previous researches it had been proven that compared to still diagrams, instructor-guided animations facilitated students' learning of chemistry, most probably by allowing students to visualize chemical reactions at the microscopic level and to create imaginative representations of those reactions. It seems that animations should be ideal for presenting dynamic contents like chemistry topics. According to Marbach *et al*., (2008), implementing animation in teaching chemistry processes could be one of the most effective methods in this field. Instructor-guided animations help students acquire a better understanding of targeted chemistry concepts.

From expositions made so far, computer animation activities engage students in interactive exercises which allow them to learn from trial and error, and repetitions over and over- none of which were possible with the illustration activity (Marbach *et al*., 2008). With animated depictions, information about the changes involved is available to be read from the display without the learner needing to perform mental animated constructions „manually". With computer animation program, students may build appropriate animations and use them to conduct higher-order thinking such as reasoning and interpretation (Chang & Quintana, 2006). Combining computer animation method and other methods may be a useful way for teaching science, and teachers may use this or another combination when teaching chemistry concepts. Reviewed literature has shown that appropriate animated learning materials were perceived as being more useful than equivalent static learning materials by students.

2.5 Using animations to enhance the understanding of acid strength concept

Acid strength refers to an acids‟ ability or tendency to lose a proton (H^+) in aqueous solution. It involves the molecular reaction between acid and water molecules to produce hydroxonium ion(s). This can be represented with the molecular formulae in a chemical equation such as follows:

$HA_{(s)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + A^-_{(aq)}$, where HA= acid molecule, A^- =conjugate base of the acid. This seems abstract to the student but when mental model building aid tools such as animations are used to represent these formulae, students‟ understanding improves. For instance, the above equation can be represented with animated diagrams such as follows:

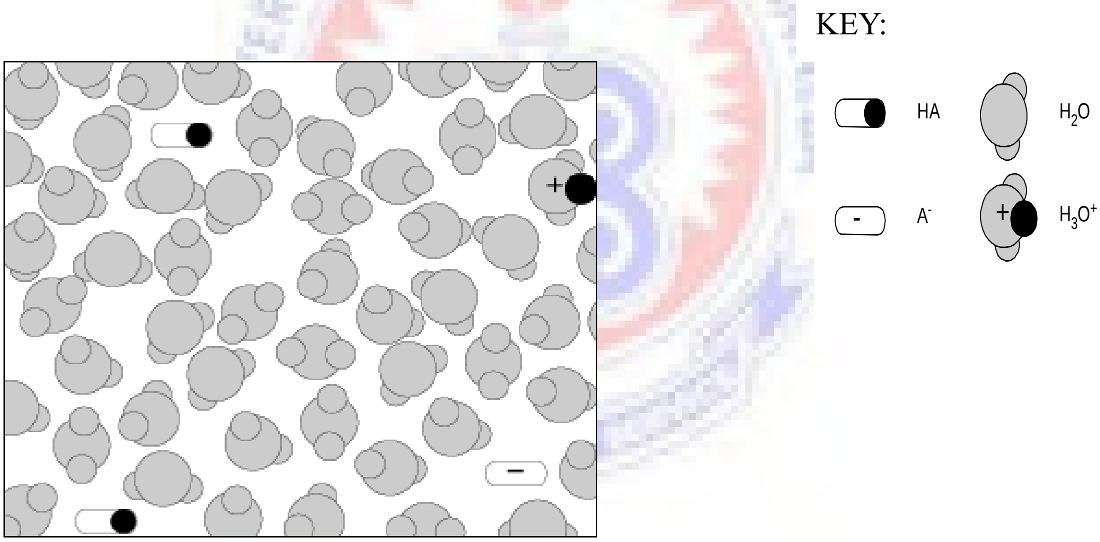

Figure 2: Animation of acid molecule in water

This makes it easy for a student to understand that:

❖ Not all acid molecules produce hydrogen ions when in aqueous solution because such molecules (some weak acid molecules) are not able to dissociate/ ionize as can be seen in the diagram.

- When acid molecule(s) dissociate the hydrogen ion(s) which is/are produced combines with water molecule(s) to form hydroxonium ion(s) leaving the conjugate base(s) alone to exist in the solution as indicated above.

According to Appling and Peake,(2004), the abstract nature of atoms and molecules can cause learning difficulties, which can be ameliorated by using models to improve the understanding of the particulate nature of matter. Rotbain, Marbach-Ad, and Stavy, (2006), reported that although physical models have traditionally been used in science classrooms, educators can now use a range of computer-based models that employ advanced visualization and animation techniques. In particular, dynamic computer-based models or animations can help students visualize the molecular process of a chemical phenomenon that might otherwise be difficult to depict (Sanger, 2000). Ozmen, Ayas, and Costu (2002) indicate that for students to understand chemistry deeply they should be able to make connection or relations among the various levels of chemical representations that are the macroscopic, the sub microscopic, and the symbolic levels. This view is supported by Coll and Treagust (2003). According to Coll and Treagust (2003), the difficulty for many chemistry learners is the interaction between the „macroscopic and the microscopic world".

2.6 The Role of Animations in Conceptual Change

Many researchers have conducted studies on the role of animations in students" conceptual change, which is said to show positive results. Lowe (2004) suggested that many animations are apparently used to fulfill an affective function, that is, to attract attention, engage the learner, and sustain motivation. According to Lowe (2004), affectively-oriented animation often portrays activity that is humorous, spectacular, or bizarre and that, in tertiary education, animations are more likely to be used for a second and very different purpose; to fulfill a cognitive function. In this role, animations are intended to support students' cognitive processes that ultimately result in them understanding the subject matter. Chang, Quintana, and Krajcik (2008) cited a study that explored the effect of computer animations on college students‟ understanding of the particulate nature of matter indicated that the group who viewed animations showed significantly higher conceptual understanding of the particulate nature of matter.

Sanger, Brecheisen, and Hynek, (2001) found that college students who viewed animations of diffusion of perfume molecules and osmosis of water molecules had better understanding of random and constant movement of particles than the students who did not view the animations. Chang and Quintana (2006) studied two roles of animations to support seventh grade students' learning of chemistry concepts: (1) animation as a constructivist tool that supports students' visualization and interpretation of abstract processes, and (2) animation as a problem solving tool that supports students' reasoning processes. For this purpose a new computer-based program, Cremation, was developed to allow students to visualize chemical processes, interpret chemical processes, and make reasoning about a chemical phenomenon. The pre and post-test results showed significant improvement of students‟understanding and interpretation of abstract chemical processes.

2.7 Summary of literature review

From the literature review, most studies conducted on the use of animations in teaching chemistry, including acid strength, have commended positively on how it helped improved the academic performance of low grade class students such as the findings of Marbach-Ad, *et al*., (2008), Ozmen, *et al*., (2009) and Aksoy (2012) while a few other studies have shown a rather negative impacts of animations on students‟ conceptual content knowledge such as the findings of Tversky (2003), Martin & Tversky (2003), Tasker Dalton, Sleet, Bucat, Chia and Corrigan (2002),and others.

However, for the fact that many factors could affect the findings of a study such as the individual teaching philosophy, and educational settings, ones‟ findings may not be conclusive of another. Sahlberg (2006) notes that the direct copying or transfer of curriculum from another jurisdiction as a means of addressing mobility and qualifications, without taking into account cultural and political differences, teaching traditions and provision of education is not advisable. Also, considering the report in Falvo‟s journal by Lidwell, Holden, and Butler (2003) which suggests that aesthetic and attractiveness propels students „attitude towards using animations, this study was conducted with the hope that since this is the first of its‟ kind in the school, it could attract and motivate students to learning chemistry.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter describes the research design, population and sample procedure, instrumentation, validity, reliability of the instruments. It also describes data collection procedure, analysis and interpretation. The pre-intervention and intervention are also discussed in this chapter.

3.1 Research Design

The study employed interviews and a pre – test exercise as pre- intervention strategies to help identify students ‟problems in the topic under study. The outcome of the pre-intervention strategies contributed to the design of intervention activities for the students. A post-intervention test was administered to the students after the intervention activities to assess its impact on teaching and learning, especially of acid strength.

3.2 Population and Sample Procedure

The sample chosen for the study was Form Three Agriculture students at Kusanaba SHS at Kusanaba in the Bawku-West District of the Upper East Region. The hundred (100) students of the Agriculture class came from two classes made up of eighty 80 boys and 20 girls. A purposive random sampling technique was employed in attaining this sample.

3.3 Instrumentation

The instruments used for the study consisted of interviews, pre-intervention test and post- intervention test.

3.4 Validity and Reliability of the Instrument

The instruments used in this work were discussed with my supervisor where some items were modified for the sake of relevancy. It was also discussed among other chemistry teachers of the school where it was proven to be valid and reliable for the study purpose.

3.5 Data collection procedure

This study was conducted within a week. In the pre-test, same questions were administered to the students of the two classes to help identify student difficulties in acid strength. This was followed by a focus group discussion with the hundred students in a class to find out why they performed woefully in the pre-test and how they could improve on their performance.

There was one experimental group and one control group. The classroom instruction for both groups had 120-minutes within the week. The same topics were covered for both groups. Treatments were randomly assigned to the two classes by the Researcher. In the control group, students received instruction through the traditional method. The Researcher followed teacher illustration and discussion method to teach acid strength concept. Teaching strategies relied on teacher"s explanation and textbooks. The Researcher structured the entire class as a unit, wrote notes on the board about the definition of the study concepts and solved problems on the study concepts with the students.

The experimental group received their lessons through computer animated visualization where they were made to visualize animations on a projected screen. This was done to check the effectiveness of the use of animations as an instructional tool for enhancing teaching-learning at Kusanaba SHS. After the intervention, a period of one week was given to students to prepare for the post-test.

In the post-test, the same sets of questions were given to the students in each class to answer within the same time. This was done to check which method of teaching enhanced the conceptual understanding of students better. The data collected from both pre -intervention and post-intervention activities were examined for consistency by reading through the scores obtained by the students.

3.6 Scoring the Instrument

The instrument was scored with the help of these conceptual indicators:

- The definition of acid strength
- The meaning of strong acid
- The meaning of weak acid
- Determinants of acid strength;

3.7 Pre-Intervention Activities

The following activities were carried out to help identify the problems associated with the teaching and learning of acid strength.

- The Researcher visited a class that was having a lesson on acid strength to observe how the topic was taught. This was followed by interviews on two teachers who teach the same subject to find out why students performed poorly in acid strength and its associated problems.
- Pre-test questions were administered to the students of the two classes on a pre-determined day. An allocated time of thirty minutes was given to students to finish answering the questions individually after which the answer papers were taken from them.
- The Researcher met the two classes as a combined class and had a focus group discussion with them on the problems associated with the teaching and learning of acid strength and the way forward.

3.8 Intervention Activities

An intervention design was drawn up to address identified problems that students face on the acid strength concept and its related topics in two lessons followed by a recommendation. The intervention strategies included:

1. Explaining the term acid strength, representing the definition with a chemical equation, defining the terms strong and weak acids,
2. Classification of acidic solutions
3. End of course test.

3.9 Explaining acid strength

Under this strategy the Researcher designed a lesson to help students understand the meaning of acid strength. The lesson involved two activities. In the first activity, students were asked to define the concepts strong and weak acids. This was a follow up of the previous lesson on nature of acids. The Researcher expected students to use their previous knowledge on nature of acids to define the mentioned concepts.

Following this, two computer animated diagrams of strong and weak acids (Appendix D) were shown on a screen using computer and a projector and students, kept in groups were asked to observe the diagrams critically and tell if they could find any differences in them. The students were also asked to use the diagrams to explain the terms strong and weak acids. In a second activity, students, again in groups were asked to mention some common strong acids and compare their strength.

3.10 Classification of acidic solution

A second lesson, also consisting two activities was designed by the Researcher to improve the performance of the students on the classification of acidic solutions. In groups, students were asked to use their previous knowledge on balancing of chemical equations to write out an equation to represent the acid dissolving in water. Following this, the Researcher showed a screen of four different computer animated diagrams of different amounts of ionized acid molecules with questions attached.

Guided by the Researcher in using a key, students were required to observe and use the shown diagrams to classify the solutions. The two lessons and the activities done during the intervention are indicated in Appendix B.

3.11 Mode of Data Analysis

The data collected from both pre-test and post-test exercises were analyzed by use of descriptive statistics where the mean scores and standard deviations were compared to ascertain the effectiveness of the intervention. The focus group discussion with the students and the interviews with colleague subject teachers were analyzed by cross checks with students‟attitude to confirm the immerging issues.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Overview

This chapter entails presentation of results of the pre-test and post- test exercises. It also includes analysis and discussions which compares the results of both tests in the light of the research questions.

4.1 Presentation of Results

The tables below show the results for test items, the number of participating students who worked each item correctly, and their corresponding percentages in the pre and post- test exercises. In Table 4.1, the results of students‟ performance in the pre-test are presented as figures and percentages.

Table 4.1: Results of Pre- Test

Question number	Number of students	Students with correct answers	Percentage
1	100	74	74
2	100	60	60
3	100	48	48
4	100	60	60
5	100	43	43
6	100	37	37
7	100	29	29
8	100	5	5

From Table 4.1 above, the students‟ submissions from the pre- test exercise indicated that they had low understanding of the acid concept and barely understood what the concept of acid strength was. Out of the 100 students who participated in the pre- test, 74% of them had itemed one correct when they were asked to select the non-acidic molecule among the listed number of molecules. This was indicative that some of them have misconceptions about acids and bases. In an interaction with some students, it came to light that students had the perception that any molecule containing hydrogen atom is acidic. Since all the molecules contained hydrogen atoms, they were all acidic and so they were confused. A good number, about 40% of them did not know that the pH of acids are lower than 7 was the correct answer to item two. The most prevalent misconceptions the students had were observed in items four, seven and eight. In item four, students were asked to choose from among four optional suggestions the one that should be definitely known in other to understand the strength of an acid. Only 29% of them chose the correct option that it is the one with percent ionization in water. The same percent of students found it difficult to choose from solutions A of 0.005 $moldm^{-3}$ and B of $0.5moldm^{-}$,^{3} the one that is more diluted and to explain why those answers to item seven. Some were able to make the correct choice that it was solution A but could not explain. In item eight, students were given a list of three acid molecules (HBr, HCl and H_2SO_4) to select the least and the strongest acid. Only five of them selected HCl as the least acidic and H_2SO_4 as the strongest acid. Most of them chose H_2SO_4 as the least and HCl as the strongest acid. The responses obtained from the pre- test exercise triggered the current study of students‟ difficulties on the concept of acid strength. The obtained results indicated that most students merely resorted to memorization of the supposed abstract concepts. For example, it was observed that almost all the students attempted all the multiple choice items as well as item 6 of the theory part (Appendix

D). This was because the said items did not require high order thinking or reasoning but factual answers and so most students, without haste, answered them quickly. A copy of these questions is found in Appendix D. The result of the post- test is presented in Table 4.2.

Table 4.2: Results of Post- Test

Question number	**Number of students**	**Students with correct answers**	**Percentage**
1	100	65	65
2	100	70	70
3	100	59	59
4	100	58	58
5	100	61	61
6	100	68	68
7	100	60	60
8	100	70	70

From Table 4.2, it is observed that majority of the students performed well. However, most of the students who had the questions right were from the experimental group. For example, out of the 70%, 60% and 68% that had items eight, seven and six respectively, the experimental group had the higher scores. For example, 19% of the control group students had HCl as the strongest acid with the explanations that because it has strong bonds. Also in item six, only 15% of students in the control group wrote that strong acids ionize completely in aqueous solution while weak acids ionize partially when in aqueous solution.

Also, the reluctant attitude portrayed by all students during the administration of the pre- test exercise faded off with the experimental group. They were very enthusiastic to write the post- test and expressed confidence in demonstrating their understanding of the concepts under study through their performance. A comparative analysis of the performance of both the control and experimental groups in the pre- and post-tests is presented in Table 4.3 for emphasis.

Table 4.3: Comparison of students‟ performance in the pre and post- tests

	Experimental Group			**Control Group**		
Measures	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Pre-test	100	8.8	4.8	100	9.9	4.0
Post-test	100	20.0	3.3	100	14.6	6.0

N=Number of students; SD = Standard deviation

Table 4.3 above, illustrates the mean scores of students‟ performance in the pre- test and post- test exercises. In comparing the performance of students in both tests, it is clear that the experimental group had higher scores in the post-test as compared to their results in the pre- test. Also the significant improvement of the experimental group in the post test exceeds that of the control group. It was observed in the post-test that many of the control group students still hold to some of their misconceptions. The most prevalent misconception among them was that concentrated acid is a strong acid dilute acid is a weak acid.60% of them wrote this as their answer to item eight. The trend in differences of students‟performance is indicated by the mean scores. The mean score of the control group in the pre- test was higher than that of the experimental group with a difference of 1.1. The standard deviation of the control group was also less than that of the experimental group. However, in the post- test, even though the mean scores of both groups had improved, there was a significant increase of 5.4 points in the mean score of the experimental group. This time, the standard deviation of the control group exceeded that of the experimental group by a difference of 2.7. This is evidence that the techniques implemented in the intervention were appropriate, valid and reliable.

4.2 Discussion of Results in relation to Research Questions

4.2.1 Research Question 1: What conceptions would Form Three (3) General Agriculture Science students of Kusanaba S.H.S have about acid strength?

From the response of the students in the pre- test exercise before the intervention, it was evident that most of the students had poor understanding about acid strength. Nearly all of them had misconceptions or alternative concepts about terms such as „strong‟, „weak‟, „dilute‟ and „concentrated‟ acids, which are used to describe the nature of solutions. For example, the responses of some students to item 6 before the intervention were:

a. Weak acids have weak bonds while strong acids have strong bonds.
b. A dilute acid is a solution of weak acid.

Most students were found fumbling when asked to state and explain the least and the strongest acids among the list of three acid compounds in item 8. Most of them responded that HCl was the least acidic and H_2SO_4 was the strongest acid while some had H_2SO_4 as the least acidic and HCl as the strongest acid. However the trend changed tremendously after the intervention strategies. Most of them could then explain these concepts with ease as they observed the representations and interpreted their meanings through animated videos.

For example, many students in the experimental group had HCl< HBr< H2SO4 as increasing order of acid strength with the explanation that, with the same amount of each of them in an aqueous solution, H_2SO_4 produces more hydrogen ions than the rest. Also, HBr ionizes more than HCl because its radius is bigger. This is in line with the findings of Yaman and Ayas (2012). Yaman and Ayas (2012) found out that students in their study had misconceptions about P^{H}-P^{OH} and acid strength. The students had a number of common misconceptions concerning the concepts of acids.

4.2.2 Research Question 2: What aspects of animations would enhance the teaching and learning of the concept of acid strength at K.S.H.S?

Mental model building capacities were stimulated in students as they were encouraged to visualize follow up situations as would be observed in animations. This technique was used in a review of two intervention lessons before the post- test, where some questions on acid strength were asked. Students were asked to demonstrate their answers on the marker board using symbols to explain. For example, students were asked to compare the acid strength of HNO_3 and HCOOH. Most of them answered it as follows; „HNO$_3$ is a strong acid while HCOOH is a weak acid. For example, if five molecules of each of the acids are dissolved in water, all the molecules of the HNO$_3$ will ionize while say one out of the five molecules of the HCOOH may ionize‟. Symbols were used to represent the molecules and the dissociated ions. They were able to represent the imaginary particles involved in a chemical system with mentally drawn models to make it look real.

Mental models as described by Gilbert, Boulter and Elmer (2000), is a representation of a phenomenon, an object, or idea. Animation is a magic/appropriate tool for conceptual change purposes and for enhancing conceptual understanding. This was realized after the intervention activities when students in the experimental group explained acid strength and its related concepts scientifically as indicated above. Additionally, when students were asked to explain the difference between strong and concentrated acids, most of the experimental group students were able to answer it correctly. Some explained that "strong acids ionize completely when in aqueous solution while concentrated acid contains higher ratio of moles of acid to the volume of solution". As discussed in the literature, the use of dynamic visual models and visual representations of chemical processes helps students to develop conceptual understanding, and promote meaningful learning by creating dynamic mental models of particulate phenomena. According to Chang et al., (2007), students find it difficult to imagine what would be happening to reacting species at the microscopic level.

Ebenezer (2001) also found that computer models permit students to link their microscopic explanations of chemical phenomena with their macroscopic observations as students can visualize microscopic processes in chemistry, and understand what is abstract in pictorial forms in their minds and in concrete representations. This was evident in the current study. Prior to the video animations, students in the experimental group found it difficult to explain sub concepts of acid strength such as strong, weak, concentrated and dilute acids in the pre- test but were able to do so in the post- test. For example, in the pre- test some of them responded to item 3 as “strong acids are more concentrated than weak acids”. However, in the post- test, they answered it as “strong acids ionize completely while weak acids ionize partially when in aqueous solution.

Thus with the same moles of weak and strong acids in water, the strong acid will produce more ions than the weak acid. For example, with 2 moles of HCl and CH_3COOH each in water, HCl will produce 2 H^+ and 2Cl^- while CH_3COOH may produce H^+, CH_3COO^- and the unionized CH_3COOH.” This response shows that, the representations of the particles (atoms, ions and the molecules) visualized in the animations helped them to picture what happens in acidic systems.

4.2.3 Research Question 3: What types of concepts would Form Three (3) General Agriculture Science students of Kusanaba S.H.S demonstrate after their use of or interaction with animations?

Animations are only but tools incorporated into educational instructions to help facilitate easy understanding of the imaginary concepts. The experimental group proved this after the intervention in this study. Before the intervention, as indicated in the pre-test, alternative concepts such as the response of some students to item 6, mentioned above changed. For example, the response of some students to item 7 in the post- test explained that strong acids ionize completely in water and that there can be a dilute solution of a strong acid provided the amount of the acid used is small, compared to the volume of water in which it is dissolved. This is a clear conceptual understanding improvement demonstrated by those students. This finding is in line with the findings of Doymus, Simsek, & Karacop (2009), Marbach-Ad, Rotbain and Stavy (2008), Ozmen, Demirciolu and Demircio (2009) Sanger, Brecheisen, and Hynek (2001)where through the use of animations, alternative conceptions or misunderstanding in the experimental groups of their studies decreased.

4.3 Pre-Intervention Findings

From the pre-test exercise, the following problems were identified as factors associated with the poor performance of students in acid strength problems:

- ❖ Some students defined acid strength as the ability of acid to ionize when in water. Others too defined it as the ability to form concentrated solution.
- ❖ Most of them described strong acids as concentrated and weak acids as dilute solutions whereas others ascribed strong acids to have strong bonds and weak acids to have weak bonds. .
- ❖ Did not know that weak acids can be concentrated neither did they know that strong acids can be diluted.

4.4 Interviews

4.4.1 Responses from the Teachers

The responses of the interviews from the chemistry teachers concerning the poor performance of students in acid strength problems included the following:

inadequate teaching and learning materials for the teaching of acid strength.

Teachers responded that the apparatus required for the practical/ demonstrative/illustrative work on acid strength concepts are inadequate, and barely in existence. Head teachers give out money for required resources only during WASSCE examination. For example, when the Researcher asked a teacher, „how often do you organize practical lessons in a term"? She responded „where do we get materials"? The other said „when you request for materials, they think otherwise about you". The teachers also responded that students complain that acid strength concepts are so abstract and difficult to comprehend. These responses indicate that the students had no opportunity to observe what happens in molecular phenomena, to be able to link the three levels of a chemical system.

4.4.2 Responses from Students

Students"responses to some of the interview questions expressed some of the challenges that they encounter with the abstractness of the concept of acid strength. Some of their responses intimated that:

1. The acid strength concept looked so abstract.
2. Most students confused strong acid for concentrated acid and weak acid for dilute acid.
3. Most students resorted to memorization in order to pass examinations.

4.5 Post -Test Findings

From the students"submissions to the items in the post- test exercise, it was observed that:

A. The conceptual understanding of the experimental group improved, since they were able to explain concepts that they couldn‟t explain before the intervention such as their responses to strong and weak acids, concentrated and dilute acids as indicated in 4.2.3 above. 4.2.

B. The control group retained some misconceptions. The Researcher realized that some students in the control group still could not differentiate between concentrated acid and strong acid, weak acid and dilute acid.

C. The control group made more errors than the experimental group. This is clearly indicated in table 4.2 above.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATION

5.0 Overview

The chapter entails the summary of the findings, drawn conclusion from the study, and recommendations.

5.1 Summary of Key Findings

Analysis of the results provides evidence that the traditional instruction was not as effective as the computer animated instruction in enhancing conceptual understanding about acid strength. It was observed that, even with illustrations and explanation given by the Researcher beside the notes given during treatment, students in the control group retained some resistant to change misconceptions. The most prevalent of these was „strong acids have strong bonds and weak acids have weak bonds‟. It was also observed that students were having problems when relating concentration in the concept of acidity. For example, „concentrated acids are strong, dilute acids are weak.‟ According to the students‟ responses during the focus group discussion, origins of the learning difficulties related to these misconceptions could be attributed mainly to inadequate acquisition of the conceptual knowledge from their basic education and to the insufficient explanation of the relevant concepts in textbooks and pamphlets.

In the current study, computer animated instruction caused significantly better acquisition of the concepts than the traditional instruction. This is proven by the significant difference in the mean scores of the two groups after the intervention. The success of experimental group students over the control group is mainly because of the instructional method employed. The activities based on computer animated visualization approach helped the students revise their prior knowledge. It also helped them eliminated their misconceptions.

Computer animations as an instructional material facilitated that process by improving the instruction. In the computer animated instruction, the representational models allowed students realize their existing conceptions, became dissatisfied with them and accepted better explanations. Enhancement of mental model building capacities through the computer animations provided better understanding of abstract concepts by serving as a bridge between the real life examples and misunderstood concepts.

Another key issue of relevance which came up during the interviews with same subject teachers was the negligence of some institutional heads to provide science equipment and chemicals for practical lessons.

5.2 Conclusion

On the basis of the findings, it could be concluded that the use of computer animations assisted Form Three (3) General Agricultural Science students of Kusanaba S.H.S to better understand dynamic molecular processes in chemistry. This explains why the experimental group of the study performed better than the traditional group in the post-test. When students visualize animations, the atomic, ionic and molecular representations enable them see what really happens in a chemical system. This will in a long round allow them realize their personal conceptions, become dissatisfied with them and accept better scientifically accepted ideas. Besides enhancing conceptual understanding, animations stimulate the interest of learning of students.

This could be seen in the attitude of students in the experimental group during the study period. Students in the experimental group showed interest in chemistry by prompting the Researcher when it was time for chemistry lessons. They were also eager and ready to write the post- test after the treatments. This most probably could be because they felt they had learnt enough to pass the test.

It is also concluded that animations stimulate mental model building abilities of learners. This explains why the Form Three (3) General Agriculture Science students of Kusanaba S.H.S in the experimental group were able to used symbols to explain the difference between weak and strong acids in a review exercise as indicated in the discussion.

5.3 Recommendations

In the light of the findings and emerging issues in this study, it is recommended that:

- Science teachers, especially chemistry teachers of Kusanaba SHS and probably other SHSs should incorporate animations in teaching topics that contain abstract concepts for easy conceptual changes, and for better conceptual understanding.

- The Ghana Education Services should organize a training programme for SHS science and chemistry teachers, training them on the use of animations for teaching.
- Science Curriculum Designers for SHS should include the use of animations in science and chemistry topics that contain complicated concepts.
- Head of SHS institutions should be encouraged to make science equipment, especially computers available for science practical when the need arises.

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APPENDIX A

ANALYSIS OF WASSCE RESULTS OF KUSANABA SHS FROM 2012-2014

2012

Total number of candidates = 190

Best Aggregate = 18

Number of candidates results not included = 0

Number of Students qualified for University = 17

Number of Candidates failed = 0

Passed in 6 or more subjects = 171

SUBJECT	NO. CANDIDATES PRESENTED	NO. ABSENT	A1	B2	B3	C4	C5	C6	D7	E8	F9	NO. PASS	% PASSED
ENGLISH	190	0	0	0	0	3	9	87	45	36	10	180	95
CORE MATHS	190	0	0	0	3	1	3	29	48	66	40	150	79
INT. SCIENCE	190	0	0	0	3	4	8	58	82	32	3	187	98
SOCIAL STUDIES	190	2	7	19	96	28	24	10	4	0	0	188	99
ELECTIVE MATHS	82	0	0	0	0	1	1	1	3	30	46	36	44
GENERAL AGRIC.	78	0	0	0	2	0	5	13	36	20	2	76	97
CROP HUSB. & HORT.	77	0	0	0	5	2	9	30	27	4	0	77	100
CHEMISTRY	78	0	0	0	0	0	0	0	2	13	63	15	19
PRIN. OF COST ACC.	54	0	10	6	25	2	6	3	2	0	0	54	100
BUSINESS MANA.	55	0	2	3	20	5	5	7	8	4	1	54	98
FINANCIAL ACC.	55	0	0	1	1	0	4	8	12	7	22	33	60
ECONOMICS	111	0	0	0	7	12	15	53	19	4	1	110	99
GOVERNMENT	56	0	0	0	6	7	2	14	16	5	6	50	89
HISTORY	53	0	0	2	10	8	4	14	8	3	4	49	92
GEOGRAPHY	35	0	4	3	6	1	8	12	1	0	0	35	100

2013

Total number of candidates	=	361
Candidates absent	=	3
Best aggregate	=	17
Number of candidates results not included	=	0
Number qualified for tertiary institutions	=	12
Number of candidates failed	=	0
Passes in 6 or more subjects	=	327

SUBJECT	NO. CANDIDATES. PRESENTED	NO. AB	A1	B2	B3	C4	C5	C6	D7	E8	F9	NO. PASS	% PASS.
ENGLISH	361	3	0	0	1	3	18	16	113	46	9	349	97
CORE MATHS	361	3	0	0	1	2	2	21	69	159	104	254	71
INT.SCIENCE	361	3	0	1	21	17	37	102	123	47	10	348	97
SOCIAL STUD.	361	3	12	45	155	34	48	43	18	3	0	358	100
ELE. MATHS	129	2	0	0	0	0	1	9	26	60	31	96	24
GEN. AGRIC.	121	2	0	0	2	3	5	22	52	24	11	108	91
C. HUSB. & H.	121	2	0	0	0	1	0	16	39	47	16	103	87
CHEMISTRY	121	2	0	0	1	0	2	4	14	23	75	44	37
PRIN. COST.	114	1	28	12	29	4	8	16	10	6	0	113	100
BUS. MANA.	114	1	1	4	28	18	16	23	18	4	1	112	99
FIN. ACC.	114	1	0	1	23	9	12	30	23	11	4	109	96
ECON.	240	1	0	1	5	7	27	84	60	40	15	224	93
GOV.	126	0	8	11	52	30	16	5	4	0	0	126	100
HISTORY	118	0	0	0	4	4	11	29	32	32	6	112	95
GEOG.	126	0	3	8	35	21	19	30	6	4	0	126	100

2014

Total number of candidates	=	287
Candidates absent	=	8
Best aggregate	=	15
Number of candidates results not included	=	0
Number qualified for tertiary institutions	=	37
Number of candidates failed	=	0
Passes in 6 or more subjects	=	327

SUBJECT	NO. CANDIDATES PRESEENTED	NO. AB	A1	B2	B3	C4	C5	C6	D7	E8	F9	NO. PASS	% PASS.
ENGLISH	287	3	0	0	1	3	18	16	113	46	9	131	97
CORE MATHS	287	3	0	0	1	2	2	21	69	159	104	134	71
INT. SCIENCE	287	3	0	1	21	17	37	2	3	47	169	118	97
SOCIAL STUD.	287	3	12	45	5	34	48	43	18	3	76	220	86
ELE. MATHS	106	2	0	0	0	0	1	9	26	54	10	96	24
GEN. AGRI.	100	2	0	0	2	3	5	22	24	24	8	90	91
C. HUSB. & H.	100	2	0	0	0	1	0	16	39	9	10	88	87
CHEMISTRY	100	2	0	0	1	0	2	4	14	18	54	44	37
PRIN. COST.	94	1	28	12	29	4	8	16	10	6	0	93	100
BUS. MANA.	94	1	1	4	28	18	16	23	18	4	3	90	99
FIN. ACC.	**94**	**1**	**0**	**1**	**23**	**9**	**12**	**30**	**23**	**11**	**14**	**80**	**96**
ECON.	94	1	0	1	4	3	7	4	9	22	33	61	40
GOV.	93	0	8	11	52	30	16	5	4	0	22	71	78
HISTORY	93	0	0	0	4	4	6	10	22	32	7	86	57
GEOG.	93	0	3	4	5	21	19	14	6	4	17	76	85

APPENDIX B

LESSONS AND ANIMATED ACTIVITIES

Lesson One

Topic: Definition of Acid strength.

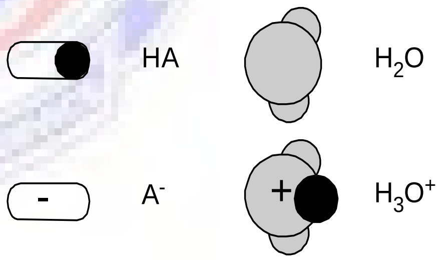
Activity 1

From student‟s previous knowledge on the nature of acids in previous lesson, they were asked to define strong and weak acids.

Activity 2

From the student‟s submissions, the researcher used the key below to explain the two with the following diagrams:

Key:



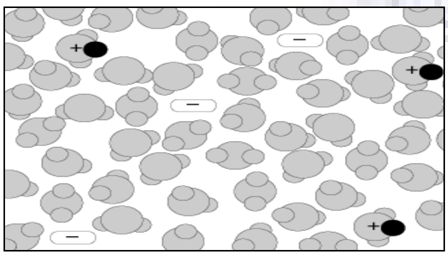


Diagram 1

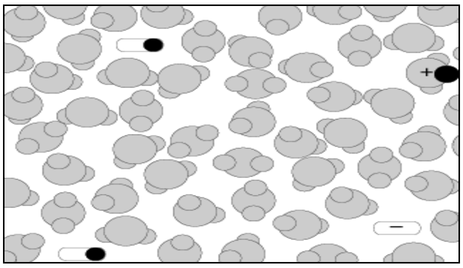


Diagram 2

According to the researcher, each diagram contains three moles of acid molecules. However, in the first diagram all the three molecules have completely dissociated to produce three hydrogen ions which have combined with three water molecules to form three hydroxonium ions whereas in the second diagram, only one out of the three acid molecules have dissociated to produce one hydrogen ion which has combined with one water molecule to form one hydroxonium ion. Diagram 2 contains weak acid molecules which do not dissociate with ease to release hydrogen ions while Diagram 1 contains strong acid molecules which dissociate easily to release hydrogen ions in solution.

Activity 3

Determining acid strength

From the explanation above and from students‟ previous knowledge on factors which affect bond strength, students were asked to mention some common strong acids and compare their strengths. This exercise was followed up with the explanation that the strength of an acid, could be determined without the use of pH calculations.

Lesson Two

Topic: Writing equation for an acid that dissolves in water.

Activity 1

Based upon students‟ own previous knowledge on balancing of chemical equations, they were asked to represent the dissolution of acid in water with a balanced chemical equation.

Activity 2

The Researcher explained that one way to write the equation for an acid „HA‟ dissolving in water was as follows:

$HA_{(s)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + A^-_{(aq)}$

"The A in HA does not stand for a particular element, but for the „acid radical‟ part of the molecule. So, for example, in hydrochloric acid „HA‟ would be HCl, and „A^-‟ would be Cl^-, whilst in ethanoic acid „HA‟ would be CH_3COOH, and „A^-‟ would be CH_3COO^-."

Activity 3

Classification of acidic solutions

The Researcher explained that acidic solutions could be classified as being concentrated or dilute. This was followed by the use of animations designed to highlight the aspects of the various systems. Students were kept in groups of five to solve the problems following the diagrams.

Problems:

Teacher: Look carefully at the four diagrams on the following pages, and write down the differences that you observe.

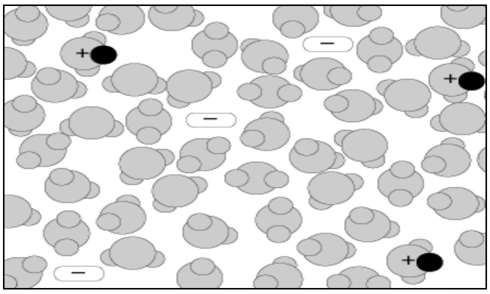


Diagram 1

1. What types of particles are shown in the solution represented in diagram 1?

2.How would you describe this solution?

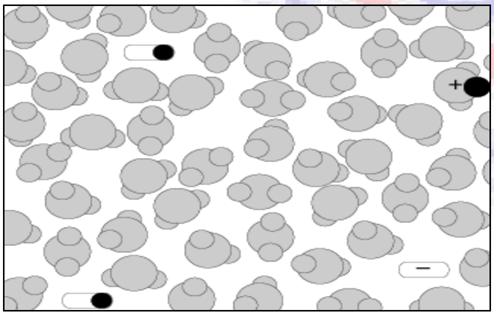


Diagram 2

3.What types of particles are shown in the solution represented in diagram 2?

4.How would you describe this solution (compared to diagram 1)?

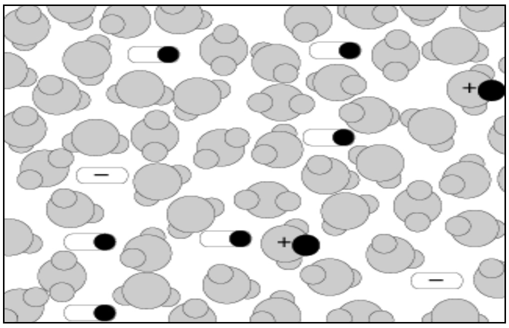


Figure 1

Diagram 3

1. What types of particles are shown in the solution represented in diagram 3?

2. How would you describe this solution (compared to diagrams 1 and 2)?

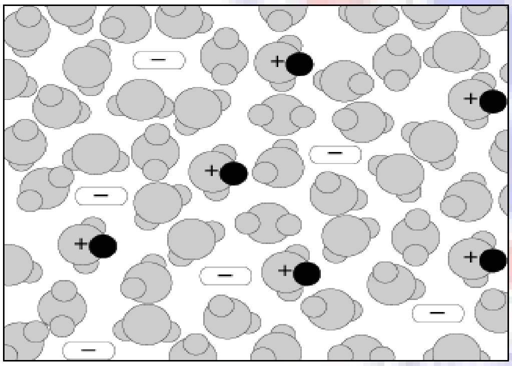


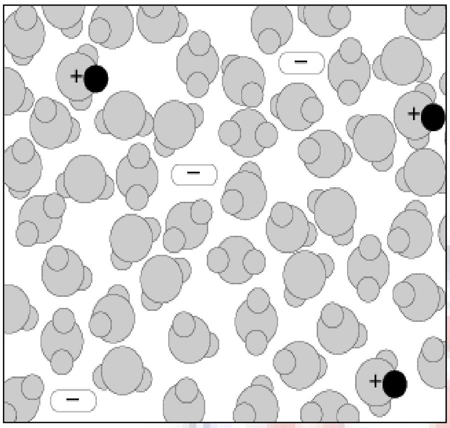
Diagram 4

7. What types of particles are shown in the solution represented in diagram 4?

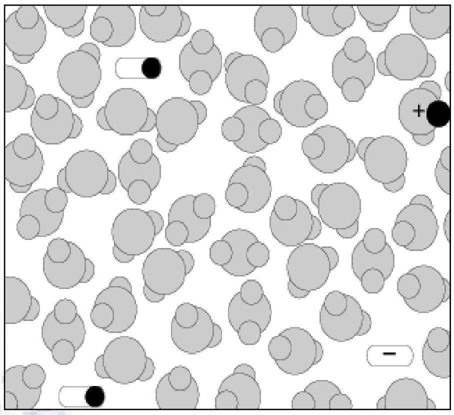
8. How would you describe this solution (compared to diagrams 1-3)?

9.The four diagrams you were asked to consider are reproduced in miniature below;

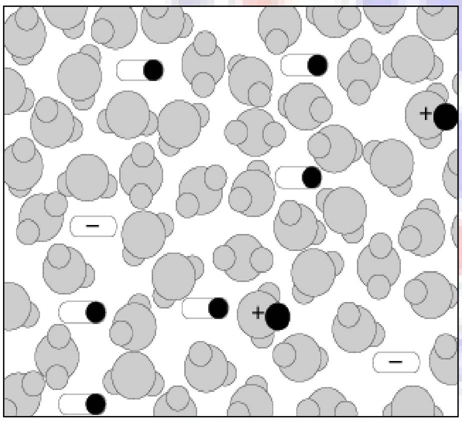
1



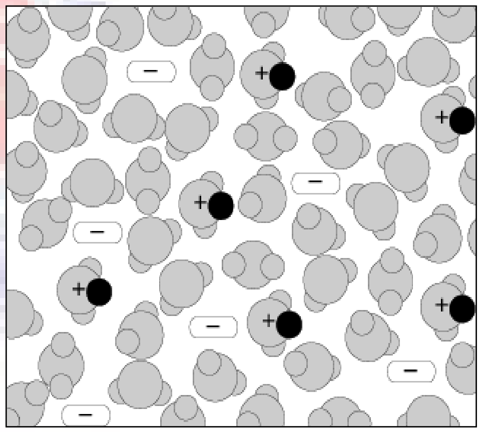
2



3



4



The diagrams are meant to represent a concentrated solution of a strong acid, a dilute solution of a strong acid, a concentrated solution of a weak acid and a dilute solution of a weak acid.

Use the table below to show which diagram is meant to represent each of the four solutions – write the number of the appropriate diagram in each box.

	Strong	**Weak**
Concentrated		
Dilute		

The students were guided by the Researcher to use the key given earlier to find solutions to the problems.

Solution

1. Based on the key given earlier, the particles in diagram 1 are; water molecules, hydroxonium ions, and conjugate bases of acid molecules.
2. They can be described as dilute solution of strong acid.
3. Particles present in diagram 2 are; acid molecules, water molecules, hydroxonium ion, conjugate base of an acid molecule.
4. The solution can be described as a dilute solution of a weak acid.

5. The particles present in diagram 3 are; acid molecules, water molecules, less hydroxonium ions than the one in diagram 1 and conjugate bases of acid molecules.
6. The solution can be described as a concentrated solution of weak acid.
7. The particles present in diagram 4 are; water molecules, more hydroxonium ions than the solutions in diagram 1, 2 and 3, and conjugate bases of acid molecules.
8. The solution can be described as a concentrated solution of a strong acid.

9.

	Strong	Weak
Concentrated	4	3
Dilute	1	2

APPENDIX C

LESSON NOTES

WEEK ENDING: 11TH NOVEMBER, 2014

SUBJECT: CHEMISTRY CLASS: AGRIC 3A

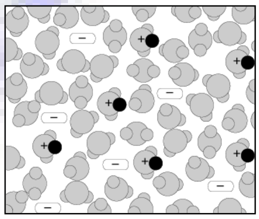
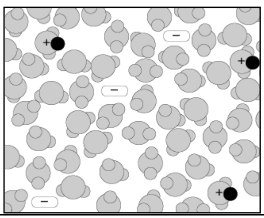
FORM: THREE

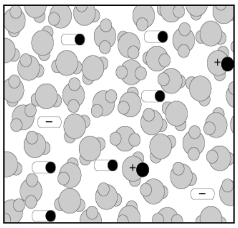
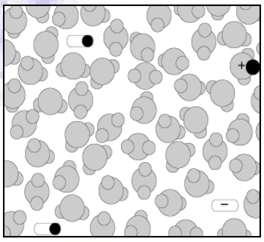
TIME: 11:05-11 45AM

REFERENCES:

CHEMISTRY GAST, (1998) (1st Ed.), pp. 37-38.
Kosoko, V. (2008), Ultimate chemistry. Vol. II, pp. 6-7.

DAY/ DURATION	TOPIC/ SUBTOPIC	OBJECTIVES	RPK	TLM	TEACHING/LEARNING ACTIVITY	EVALUATION
DAY: Wednesday DURATION: 40 minutes	TOPIC: Acids, Bases and Salt SUBTOPIC: classification of acidic solution	By the end of the lesson, students will be able to : use the computer animated diagrams to classify acidic solution into :	Students have knowledge in: Strong acids and weak acids. Students also have knowledge in how to write chemical equatio	Computer animated diagrams	INTRODUCTION STEP I: Teacher introduces the topic by reviewing students" previous knowledge on: 1. Classification of acids with the help of computer animations. 2. Writing of chemical equations to represent the acid dissolving in water.	Assignment: 1. Define the terms concentrated acid and dilute acids 2. State two differences between weak acid concentrated solution and strong acid

	ns to represent the dissolution of acids in water.	STEP II Teacher explains that the resulting solution can be classified as either concentrated or dilute acid. STEP III Teacher divides students into groups. Teacher provides computer animated diagrams to students and ask them to : Identify the type of particles found in each diagram and as well describe the solution.	concentrated solution. References: Chemistry GAST, pp.37-38. Kov's series, vol. II, pp.6-7.
1.Strong acid concentrated solution		Diagram 1  Particles present: Hydroxonium ions and conjugate base of acid.	
2.Strong acid dilute solution			

	Particles present: Hydroxonium ions and conjugate base of acid.
3.Weak acid concentrated solution and	Diagram 3  Particles present: Acid molecules, hydroxonium ions, and conjugate base of acid.
4.Weak acid dilute solution	Diagram 4  Particles present: acid molecules, hydroxonium ion and conjugate base of acid.

APPENDIX D

PRE AND POST - TEST QUESTIONS

Pre Test Questions

1) Which of the following is not an acid?

a. CH_5COOH | c. H_3PO_5

b. NH_3 | d. HNO_3

2) Which one of the following statement(s) is TRUELY related to acids?

I-they form concentrated solutions

II- they form saturated solutions

III-pH of acids are lower than 7

VI-strong acids only react with strong bases and weak acids only react with weak bases

a. only II | c. I and II

b. only II | d. II and IV

3) What is the difference between strong and weak acids?

a. strong acids have higher pH than weak acids

b. strong acids contain more hydrogen bond than weak acids

c. strong acids are more concentrated than weak acids

d. strong acids ionizes more than weak acids

4) To understand the strength of an acid, which one of the following(s) should be definitely known?

I- concentration

II- number of H atom in its structure

III- percent ionization in water

IV -pH value

a. I and II

c. II and III

b. only III

d. II and IV

5) What do you understand from the notion that a solution is a concentrated acid?

a. If the number of H atoms in the formula is large.

b. If the acid is concentrated it is related with being strong.

c. If the acid is concentrated it means it is saturated

d. If the amount of solute per unit volume of solvent is high

[5 marks]

6) Distinguish between the following pairs:

a. weak and strong acids

b. weak and dilute acids.

[10 marks]

7) A science teacher, working in the laboratory sent one of his students to the store room to bring the most diluted solution of sulphuric acid. Unfortunately, the student went and saw two containers: A of 0.005 $moldm^{-3}$ and B of $0.5moldm^{-3}$. Choose and explain which of the solutions the student should pick. [5 marks]

8) State and explain which of the following is the least and which the strongest acid is: HCOOH, HCl and H_2SO_4. [10 marks]

Post Test Questions

1) What is the difference between strong and weak acids?

   a. strong acids have higher pH than weak acids

   b. strong acids contain more hydrogen bond than weak acids

   c. strong acids are more concentrated than weak acids

   d. strong acids ionizes more than weak acids.

2) To understand the strength of an acid, which one of the following should be definitely known?

   I- concentration

   II- number of H atom in its structure

   III- percent ionization in water

   IV -pH value

   a. I and II c. II and III

   b. only III d. II and IV

3) Which of the following are strong acids?

   a. HCl c. $HClO_3$

   b. NH_4^+ d. HF

4) HX is a stronger acid than HY. Which of the following is the strongest base?

   a. X^- c. HY

   b. HX d. Y^-

5) The acids in order of decreasing strength are:

   a. $HCO_3^- > H_2CO_3$

   b. $H_2CO_3 > H_3PO_4$

c. $H_2PO_4^- > H_3PO_4$

d. $HCO_3^- > H_2PO_4^-$

e. $H_3PO_4 > H_2CO_3$.

[5 marks]

6) Arrange the following in order of increasing acid strength: HF, H_2SO_4, HCl. Explain your answer.

[5 marks]

7) What is the difference between

a. strong and concentrated acids?

b. strong and dilute acids?

[10 marks]

8) What is the relationship between concentration and the strength of an acid?

[10 marks]

APPENDIX E

PICTURES OF THE RESEARCHER AND THE PARTICIPATING STUDENTS

Pictures of the Researcher and the participating students in some chemistry lessons.

Agric 3B students titrating in the chemistry laboratory

Agric 3A students titrating in the chemistry laboratory

Victoria‟s students testing for some ions in the laboratory

Victoria and her students