Effects of implementing animation in teaching chemistry

Chemistry is often regarded as a difficult subject, an observation which sometimes repels learners from learning this subject. In recent years, instructors and teachers try to bring new methods of teaching in the science and chemistry field to make them more interesting and more understandable for learners. In fact, bringing technology to classrooms for facilitating teaching and learning process is one of the most popular methods these days. This paper seeks to bring together the general findings obtained from some researches over the past few years to determine whether the use of animation in chemistry teaching especially for secondary school students can contribute to student achievement in better understanding of this subject.

INTRODUCTION

The popularity of using animations to help students to understand and remember information has greatly increased since the advent of powerful graphics-oriented computers. In recent years technology allows animations to be produced much more easily and cheaply than in former years. These days instructors use animation in their teaching instructions especially in those subjects that are difficult for students to understand. Science is one of these subjects. In the field of science there should be an essential strategy to create an environment for students to have an extensive understanding together with deep interest to improve the overall quality of science education.

One of the most important subjects in the field of science is chemistry. This field includes so many complicated concepts and difficult subjects to learn at

all level of schooling. Concepts such as the particulate nature of matter, physical and chemical change, chemical equilibrium, solutions, acids and bases, chemical bonding, and conservation of mass are topics that students have difficulties in visualizing at sub microscopic level (Tyson, Treagust, & Bucat, 1999). Various teaching materials and methods should be utilized in order to teach the subjects effectively and put those into practice. High technology increases the alternatives in the material used for the education processes in educational institutes (Dasdemir, Doymus, Åžimsek & Karacop, 2008). The use of visualization is important for teaching chemistry concepts. Instructors have been using demonstrations in the classroom as a teaching technique for many years. Demonstrations in chemistry are visualizations at a macroscopic level that enable the student to observe phenomena, as they would be experienced in an experimental laboratory setting (Vel ´azquez-Marcano et al. , 2004).

Animations and simulations visually help students understand difficult concepts related to the dynamics of complex chemical systems including molecules and reactions (Kozma & Russell, 2005). Teachers for conveying important scientific concepts in chemistry and molecular biology, use animated visualizations that show both structures and processes. Designers of these animations benefit from knowing how students perceive and comprehend such visualizations. Specifically, instructional designers attempt to design visualizations that allow students to learn critical concepts and relationships between these concepts. Combining animations with microcomputer based laboratory experiments supports student integration

of multiple representations of chemistry concepts (Suits, Kunze, & Diack, 2005).

There are many benefits of implementing animation in science teaching especially chemistry teaching. Therefore, there have been numbers of studies done in this field to find the advantages and disadvantages of this technique. In this paper some of these researches about use of animation in teaching and learning of chemistry, have been reviewed.

2 . ANIMATIONS FOR CHEMICAL EDUCATION

To address the different learning styles of students, the use of digital animation in teaching science and especially in chemistry has become increasingly popular. Animation is a Latin word that means to revive. Animation is an alive, stripped and detailed form of computer. Because of their dynamic characteristics, animations indicate the change in figures or colours, emergence and extinction of some situations in realization process of the events. These changes may be either graphic, picture or caricature. Animations are effective aids for teaching concepts that involve motion in the molecular level. Students make mental model based on observation that are personal, qualitative and often in complement. The use of dynamic visual models visual representations of chemical processes help students develop conceptual understanding, promote meaningful learning by create dynamic mental models of particulate phenomena. Computer models permit students to link their microscopic explanations of chemical phenomena with their macroscopic observations and when students can visualize microscopic processes in chemistry, they have better understanding of chemical knowledge (Ebenezer, 2001). Computer animation, in particular, is a new

educational tool that fosters long-term learning by calling attention to objects during the early steps of instruction (Gagne´, 1985; Rieber, 1994).

2. 1 Difficulties in Teaching of Chemistry

Chemistry is one of the most important branches of science; it facilitates learners' understanding about 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. The reasons for students' difficulties vary from the abstract nature of many chemistry concepts to the difficulty of the language of chemistry (Ozmen, DemirciogË˜lu & DemirciogË˜lu, 2009).

To understand chemistry deeply, students should be able to make connection or relations among the levels. Chemistry knowledge is classified to three levels; the macroscopic, the sub microscopic, and the symbolic. Structure between molecules and atoms which take place at a sub microscopic level must be illustrated by instructors. (H. Ozmen, Ayas, A., & Costu, B., 2002) (H. Ozmen, Ayas, A., & Costu, B., 2002). Numerous reports support the view that the interplay between macroscopic and microscopic worlds is a source of difficulty for many chemistry learners.

Coll & Treagust (2003) supported point of view that the difficulty for many chemistry learners is the interaction between macroscopic and a microscopic world. Gabel (1993) found that linking the particular nature of matter to other levels (macroscopic and symbolic levels) is effective in helping students to make connections between the three levels. Gabel concluded that students have difficulty in applying their knowledge and they do not

extend their knowledge into the real world. The problem that many students encounter while studying structural chemistry is the need to apply a kind of spatial form and visualize the molecule in 3-dimention that are shown by two-dimensional diagrams in the books. In chemistry, three- dimensional visualization is an important skill. Students don’t have the ability to learn spatial shape in text book or chalkboard in 2-dimention diagram. . When students don’t have good conceptualized from concepts of science and get less marks in science exams; they don’t enjoy chemistry class, therefore, the class become boring for them that it leads to reduction in their attitude toward chemistry lessons. Students seem struggling to make the forms of mental model which is necessary to understand and comprehend the actions of the unobservable things such as atoms and molecules in chemical equations. Digital and computer animation is one of the effective strategies for meaningful chemistry instruction.

2. 2 Previous Studies on Implementing Animation in Teaching Chemistry

It is universally accepted that the quality of education depends on the quality of instructions imparted in the class room. To improve quality of science education, using the exciting technique of animation will bring a better understanding of scientific principles for learners. There is lot of research done in this region.

Simsek (2009) investigated the effectiveness of animation , dynamic three and two dimension graphic representation, and cooperative learning method on students’ comprehension of chemistry concepts involving aqueous solution. The participants were first year undergraduate of general chemistry

course. They were divided into three groups; animation, cooperative, and traditional group. The cooperative group students learned their subtopic by research and experiment in small groups. The animation group was taught by dynamic animation. The result of analyses of tests scores showed both experimental groups had significantly higher understanding conceptual scores than the control group. Those students that participated in the animation group had fewer misunderstanding.

Eun-mi Yang and Thomas Andre (2003) assessed the impact of computer animations illustrating the chemical reactions that occur inside a battery (electrochemistry) on students in a college chemistry course. Subjects divided to Computer Animation Group (CAG) who received the dynamic visualization and the Still Diagrams Group (SDG) who received same lecture but still diagrams replaced the dynamic animations. The result of analysis on post test shows significant effect of treatment. Animations, with parallel verbal narration provided by an instructor, allow students to visually follow the movement of ions and electrons and thereby create a better understanding of electrochemical processes.

A study was conducted by Dasdemir, Doymu & 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 the primary school students and the opinions of students related to teaching with the animations. Research had a quasi-experimental design. Animation group was taught by computer animations in acids bases topic, and control group was taught by traditional method in same topic. After an exam, findings showed that mean scores of animation group test significantly was

better than the control group. Also animation group had positive opinion about teaching with the help of animation instructional method.

Ozmen, Demirciolu & Demircio (2009) determine the effect of conceptual change texts accompanied with computer animations on 11th grade students' understanding and alternative conceptions related to chemical bonding. Students in 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 has shown that experimental group had significantly better understanding on chemical bonding than comparison group. Also conceptual change texts accompanied with animations, decrease alternative conceptions or misunderstanding in experimental group.

DoymuÅŸ, ÅžimÅŸek and Karaçöp (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 are evaluated in experimental design by post-test scores. The result showed that students in animation group and cooperative group had significantly difference than traditional group in microscopic level. There was 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 are used.

Akp nar and Ergin (2007) studied the effect of computer animations accompanied with experiments over traditionally designed Instruction in 6th grade students' physics achievement and attitudes toward science. The study carried out in quasi-experimental design by pre-test/post-test. Analyses of finding show that using interactive computer animation accompanied with real science experiments was significantly more effective in students' achievement 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.

In another study Ebenezer (2001) was studying about " a hypermedia environment to explore and negotiate student's conceptions: animation of solution process of table salt" with 11th grade students. Hypermedia environment consists of text, graphics, photographic images, animations, sound, and audio or video sequences. The data concerning students' understandings and negotiation of meanings were collected through HyperCard. In this study animations in the hypermedia environment enabled students to visualize how melting is different from dissolving, how ions are formed, and how hydration took place. They were able to write the corresponding ionic equations. So animation can be used to explore, negotiate, and assess students' conceptions of the sub microscopic aspects of solution chemistry.

Velazquez-Marcano et. al. (2004) investigated whether video demonstrations or particulate animations helped the students' conceptual understanding, and if the order of visualizations (video or animation first) produced any

differences. General chemistry students of university were assigned in two groups: “ treatment VA” (video first, then animation), and “ treatment AV” (animation firs video). The result showed that video alone was not enough to evoke the maximum student performance. The visualization of video after the animation resulted in statistically significant improvement in student performance over showing the animation by itself. This work showed the importance of combining both types of visualizations.

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 which was taught in the traditional lecture format, and two experimental groups which received instructions that integrated a computer animation or illustration activities. Results of 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.

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, Chemation, was developed. It provides features to enable

and deliver student-generated animations, allows students (1) visualization of a chemical process, (2) interpretation of a chemical process, (3) reasoning about a chemical phenomenon. The pre- and post test result shows significant difference of students' content knowledge and positive gross effect of the learning environment.

CONCLUSION

Based on the previous researches it has 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 content like chemistry topics. According to the mentioned studies implementing animation in teaching chemistry process can be one of the most effective methods in this field. Instructor-guided animations help students acquire a better understanding of targeted chemistry concepts (Yang et al., 2003).

Computer animation activities that demonstrate the dynamic processes allowed 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 is available to be read straight from the display without the learner needing to perform mental animation. 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).

When conceptual change texts combine with computer animations are effective instructional tools to improve students' conceptual understanding of chemical concepts.(H. Ozmen, et al., 2009). The maximum effects in learning students were achieved when both computer animations and cooperative learning methods are used (Simsec, 2009). Combining the 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. Using interactive animation accompanied with real science experiments is more effective compared to using only real science experiments in primary science course (Akp nar & Ergin, 2007). Overall it has been shown that appropriate animated learning materials were perceived as being more useful than equivalent static learning materials by students.