The Effect Of Computer-Assisted Instruction On The Students Acquisition Of Science Processes Skills In Chemistry Course

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Abstract

Using computer in educational field has been classified into three groups: learning from computer, learning about computer, and learning with computer (Jonassen, 2000). It has been argued that there is an urgent need to use different teaching approaches (Al-sheikh, 1973; Bayrak & Bayram, 2010a; Zaiton, 2004). Moreover, utilizing the benefits of instructional technology such as Computer-Assisted Instruction (CAI) has become a topic of interest within the educational field. Computer-assisted instruction and its facilities probably help students to understand the chemical concepts and develop their science processes skills. This study aimed to investigate the impact of computer-assisted instruction in chemistry course on development of science processes skills by ages ranged from (17-18) from secondary school in Saudi Arabia. The study was quantitative in nature and involved (61) students in science section. For data gathering, the experimental research was conducted. The research design was randomized pretest-posttest control group design, and the researchers created science processes measurement including two dimensions namely basic science processes skills (BSPS), and integrated science processes skills (ISPS) the dependent variable was students' performance on the test of science processes skills. On the other hand, the independent variable was teaching method including two levels; traditional approach, and by using computer- assisted instruction in chemistry course. The findings revealed that the computer-assisted instruction in chemistry increases the students' performance on the basic science processes skills (BSPS).

Key Words: Teaching, Instructional Technology, Computer-Assisted Instruction, Chemistry Course, Basic and Integrated Science Processes Skills.

Introduction

The world today is witnessing rapid developments in the field of science and technology. During the last three decades, computer technology has become an integral part of classroom instruction. Jonassen (2000) has identified three domains of computer use in education. Firstly, learning from computer programs where computer programs are used directly to instruct students and direct their activities towards acquiring some particular skills and learning facts. Secondly, learning about computers where students are familiarized with computer components, hardware, software, and their functions. Thirdly, learning with computer, based on the computerized media have been prepared and developed to work as a partner mental with the learner, to facilitate student's critical thinking, and ensure a highly quality of knowledge achievement.

As part of classroom instruction in chemistry which involves studying the changes processes in behavior of atoms, the composition and characteristics of compounds include abstract concepts and theoretical models which that cannot be perceived through observation and are only obtainable through mental thinking and the visualization of physical and chemical processes (Cepni, Tas, & Kose, 2006; Kennepohl, 2007; Ozmen, 2008). Students differ in constructing abstract conceptions based on individual differences and their previous knowledge (Cepni, et al., 2006; Gladwin, Margerison, & Walker, 1992; Limniou, Papadopoulos, & Whitehead, 2009; Trindade, Fiolhais, & Almeida, 2002). Thus, it has been found that computer-assisted instruction (CAI) and computerized simulation software can help students build correct chemical concepts, provide clear understanding about atoms movement and assist to relate the basic concepts in chemistry to the real world (Akcay, Feyzioglu, & Tuysuz, 2003; Kennepohl, 2001; Limniou, et al., 2009; Ravaglia, 1995).

The term computer assisted instruction (CAI) is also known as computer aided instruction (CAI) referred to here as the method of using a computer to deliver the information in a way similar to programmed learning by employing several media such as text, graphics, audio, video, animation, and simulation (Akçay, Durmaz, Tüysüz, & Feyzioğlu, 2006; Ozmen, 2008; Simonson & Thompson, 1994). Utilization of CAI in chemistry lessons is aimed to achieve particular educational goals through gradually steps of instruction (Bayraktar, 2000; Gladwin, et al., 1992).

The literature indicates that computer-assisted instruction (CAI) in chemistry is considered a viable method to remediate some previous “misconceptions” and “alternative conception” in the students’ mind (Ozmen, 2008; Trindade, et al., 2002). It enables students to discover new methods and approaches to resolve problems (Bintas & Camli, 2009). Using computers in teaching also increases the students’ rate of achievement (Cepni, et al., 2006; Ozmen, 2008; Skinner, 1990). Additionally, computers enable students to interact with each other and with their teachers to discuss theoretical chemical concepts and related topics by using several communications channels (e.g. audio, video, simulation, etc.) (Bayrak & Bayram, 2010b; Bintas & Camli, 2009).

According to Çakir & Sarikaya (2010) the body of knowledge and technology are increasing at such a speed that it is not possible to have students learn all information available in any of the branch of knowledge. At this point, it has become all the more important to teach students several ways of accessing and evaluating knowledge, thinking logically and creatively, and thus improve their ability to solve problems. In this context, the science processes skills (SPS) have become a significant objective in the field of education (Shahali & Halim, 2010). Al-Sheikh (1973) has emphasized that scientific thinking in the highest level consists of all the mental processes and abilities that are needed to formulate a theory, then validate it. In order to achieve these processes, learning ought to be oriented towards constituting them.

The science processes is defined by certain skills used by scientists for creating knowledge, solving postulated problems and drawing valid conclusions (Karsli, Sahin, & Ayas, 2009). It can also be defined as a set of capacities and mental processes that are necessary to identify and work on a problem (Zaiton, 2004). The science processes can be classified into two major domains, namely basic and integrated science processes. Basic science processes include observing, measuring, inferring, classifying, predicting, and communicating. The students begin developing these skills starting from primary school (Çakir & Sarikaya, 2010; Karsli, et al., 2009). Secondly, the integrated science processes include defining variables operationally, formulating hypotheses, interpreting data, describing relationships between variables, and experimenting. The students start to apply most of these skills in secondary school (Shahali & Halim, 2010). The application of integrated science processes mostly rely on the basic science processes (Zaiton, 2004).

In Saudi Arabia, there is a dearth of empirical studies which have yet to be conducted in regard to using computer assisted instruction (CAI) to develop science processes skills in secondary school education. Much still remains to be empirically studied when it comes to using computer-assisted instruction in chemistry lessons.

Purpose of the Study

This study aims to investigate the impact of computer-assisted instruction in chemistry instruction for the development of science processes for secondary school students aged 17 to 18 in Saudi Arabia.

Research Questions

Is there a significant difference in science process skills (basic and integrated) of chemistry students according to the method of instruction (using CAI, traditional method)?

Research Hypotheses

The following research hypotheses were tested in the study.

H_{o1}: There are no significant differences in basic science process skills of students in chemistry education according to the method of instruction (using CAI, traditional method).

H_{o2}: There are no significant differences in integrated science process skills of students in chemistry education according to the method of instruction (using CAI, traditional method).

Study design:

The present study was conducted based on the experimental research method, specifically randomized pretest – post-test control group design. The paradigm represents tow level of treatment namely computer-associated instruction (experimental group) and the traditional method (control group). The dependent variable was basic and integrated science process skills.

Table 1: Research design

Group	Pre-Test	Teaching Method	Post-Test
Experiment	Basic Science Process Skills & Integrated Science Process Skill	Using Computer	Basic Science Process Skills & Integrated Science Process Skill
Control		Face to face	

Sample:

The sample of the current study consisted of 61 Grade 11 students. The sample was randomly assigned into two groups by using simple random sampling technique. The experimental group was (n = 30) and the control groups was (n = 31). Additionally, the experiment group was taught using a specifically designed computer program called Al-Dwalij, while the control group continued their instructions following the traditional teaching method.

Instrument:

In the present study the researchers tested science process skills including basic and integrated skills to gather the data. The basic science process skills test (BSPST) consisted of 26 multiple choice items, namely observing, measuring, inferring, classifying, predicting, and communicating. The integrated science process skills test (ISPST) consisted of 19 multiple choice items, namely defining variables operationally, formulating hypotheses, interpreting data, describing relationships between variables, and experimenting (see Table 2). The correct answer was given one point, whereas the false answer was given no point. As validation procedure, the test was evaluated by a penal of five judges selected for their expertise in teaching science. Some minor modifications were made in both BSPST and ISPST according to the feedback. In order to determine the reliability coefficient of the test, the test was also given to 48 students selected randomly from secondary schools in Saudi Arabia, which is not included in the actual study. KR-20 was applied for analyzing the reliability coefficient. The total value of KR-20 coefficient was .74.

Table 2: The Items and Number of Questions of Science Process Skills Test

Science process skills	Item	Number of question
Basic Science Process Skills Test (BSPST)	observing	1,3,6,14,22
	measuring,	2,7,10,19
	Inferring	8,11,20,21
	Classifying	4,26,25,15
	Predicting	12,9,13,18
	Communicating	5,17,16,23,24
Integrated Science Process Skills Test (ISPST)	defining variables operationally	31,33,35,37
	formulating hypotheses	28,30,32,34
	interpreting data	43,27,29,40
	describing relationships between variables	39,42,44,38
	Experimenting	36,41,45

The Al-Dwalij Chemistry Programme

The Al-Dwalij Chemistry Programme (DCP) is a chemistry software package which is provided by the Al-Dwalij instructional company. The software of DCP has been designed to be user friendly and compatible with the chemistry syllabus determined by the Ministry of Education in Saudi Arabia. Additionally, it is directed to a specific age group, namely Grade 11 students. The program can be installed on any personal computer and the software provides materials and navigation buttons arranged logically, with the exploitation of computer media such as texts, audio, images, video, and simulation. The software content includes all the scientific concepts related to Grade 11 chemistry.

Procedure for Data Collection

The experimental group was provided with an instructional programming CD – Rom called (Al-Dwalij). The programming was installed onto computer systems, and headphones were provided along with each computer. The pre-test included both the basic and integrated science processes skills test (BISPST) which were administered to every participant in this subgroup. The duration of the test was 60 – 80 minutes. After completion, the researcher trained this experimental group on the method to make use of computer and programming software and become familiar with the navigation buttons and individual use. The period of training lasted for one week and was divided into four sessions before the treatment.

The participants from the experimental group learned the instructional programme according to their individual standards and abilities. The number of the sittings was four times per week. Each session lasted for 45 minutes as part of the regular classroom instruction monitored by the subject teacher. The treatment was conducted for a period of four weeks after which all participants were subjected to the BISPST as post-test.

The control group was taught in the traditional manner of instruction on the same content used for the experimental groups. The researcher administered the same test of BISPST to the individuals of the control group as a pre-test. The chemistry teacher continued to instruct conventionally based on the objectives of each lesson according to the following procedures: preparing the students for the new topic, explaining the concepts, theories, and examples, encouraging students to participate, and using white board and color pens. After four weeks, the basic and integrated science process test was applied again as a post-test.

Data analysis

In order to compare the differences between control and experiment groups for the BISPST an independent sample t-test was employed. The assumptions of the normality and homogeneity of the variance before conducting an independent sample t-test was fulfilled.

Findings

The aim of the present study was to investigate the impact of computer-assisted instruction in chemistry lessons on development of science processes by ages ranged from (17-18) in secondary schools in Saudi Arabia.

In order to answer the research question in the current study, the mean and standard devotion of the scores received in pre-test on BSPST were calculated and the difference between the means was conducted by an independent sample t-test. The table (3) indicted that there is no individuals' differences among groups. In other words, the both groups were equal in terms of their basic science process skills before the treatment. The result findings which are obtained from the analysis were given in Table (3).

Table 3: Independent sample t-test results of pre test on BSPST.

Group	N	Mean	S.D	t	p
Experimental	30	15.40	3.01	-.563	.575
Control	31	15.80	2.61		

In addition, the mean and standard deviation of the scores received in pre-test on ISPST was calculated and the difference between the means was conducted by an independent sample t-test. The table (4) indicted that there is no individuals' differences among groups. In other words, the both groups were equal in terms of their integrated science process skills before the treatment. The result findings which are obtained from the analysis were given in Table (4).

Table 4: Independent sample t-test results of pre test ISPST.

Group	N	Mean	S.D	t	p
Experimental	30	11.96	4.34	-1.480	.144
Control	31	13.48	3.64		

H_{o1}: There are no significant differences in basic science process skills of students in chemistry education according to the method of instruction (using computer, traditional method). To test the previous hypothesis independent sample t-test of post test on basic science process skills was applied.

Table 5: Independent sample t-test results of post test on BSPST.

Group	N	Mean	S.D	t	p
Experimental	30	16.90	3.25	2.621	.011
Control	31	15.00	2.35		

As seen in the Table 5, the result of the analysis indicated that there was significant difference between experimental group (M= 16.90, SD=3.25), and control group [M=15.00, SD= 2.35; t (61) = 2.621, p= .011]. The eta squared statistic (.10) indicated a moderate effect size. The guidelines proposed by Cohen (1988) for interpreting eta squared value are: .01=small effect, .06=moderate effect, .14=large effect.

H_{o2}: There are no significant differences in integrated science process skills of students in chemistry education according to the method of instruction (using computer, traditional method)? To test the previous hypothesis independent sample t-test of post test on integrated science process skills was applied.

Table 6: Independent sample t-test results of post test on ISPST

Group	N	Mean	S.D	t	p
Experimental	30	14.63	3.03	.941	.351
Control	31	13.93	2.75		

The result of the analysis indicated that there was no significant difference between experimental group (M= 14.63, SD=3.03), and control group [M=13.93, SD= 2.75; t (61) = .941, p= .351]. The eta squared statistic (.015) indicated a small effect size.

Discussion and conclusion:

Based on the findings obtained in the study, it can be concluded that the both groups were equal in terms of their basic and integrated science process skills before the study. The result of the analysis further shows that there was a significant difference between the experimental group and the control group in terms of basic science process skills. On the other hand, a comparison of the means of the experimental and control group revealed that there was no significant difference on ISPST.

Hence, the current study indicates the successful use of CAI to enhance the cognitive abilities on BSPST for Grade 11 science students. Computer-assisted instruction gives students the opportunity to develop their knowledge and skills by themselves (Yusuf & Afolabi, 2010). They access knowledge directly from the provided programme and respond with cognitive processing such as observing, measuring, inferring, classifying, predicting, and communicating (Gladwin, et al., 1992; Kennepohl, 2001).

The computer assisted instruction helps science students to optimize their potential to develop their basic science processes skills. For instance, the computer generated three-dimensional (3D) symbols allow student to observe the abstract concepts, number of chemical bonds between the atoms, kind of hybridization of atomic orbitals, predicting numbers of covalent chemical bonds and predicting the results of chemical reactions. In addition, the computer assisted instruction helps students to classify chemical compounds into organic and inorganic compounds. It also includes a periodic table of elements and bond length and bond energy lists which allows students to compare the listed data.

The findings of this study agree with earlier findings of Bintas & Camli (2009), Cepni, Tas & Kose's (2006), Trindade, et al. (2002), Yusuf & Afolabi (2010), and also with Akçay, et al. (2006) directly related to science education and chemistry. The findings are also supported by findings of Ragasa (2008) on statistics, Baş (2010) on English, and Udousoro (2000) on mathematics.

This study highlights the fact that computer-assisted instruction (CAI) helps enhance basic science process skills of chemistry students. Science teachers in general and chemistry teachers in particular ought to integrate CAI in their classroom instruction. Additionally, it is recommended that further experimental studies are conducted which compare the results in regard to gender differences. Finally, the cooperation and continuous communication between educational institutions and commercial companies which produce educational programmes in all disciplines should be enhanced.

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