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THE EFFECT OF MICROCOMPUTER USE IN A CHEMISTRY COURSE

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ABSTRACT: The purpose of this study was to investigate the effect of classroom instruction supplemented with the Computer Aided Instruction (CAI) on tenth grade student's chemistry achievement. Two groups of students were obtained. During the units of study of mole concept and gases, the experimental group received CAI as a supplement; the control group utilized the worksheet study as a supplement to the classroom instruction. T-test analysis was used to detect the differences between the groups on achievement in chemistry. Analysis of achievement scores indicated significantly higher scores by the students in CAI.

KEY WORDS:

Computer Aided Instruction (CAI), Chemistry Achievement, Worksheet

ÖZET:

Bu araştırmada kimya dersi ile birlikte yürütülen Bilgisayar Destekli Eğitimin (BDE) Lise öğrencilerinin kimya başarılarına katkısı incelenmiştir. Bu amaçla iki grup oluşturulmuştur. Mol kavramı ve gazlar konusu işlenirken, deney grubu sınıf öğretimine ilaveten BDE den, kontrol grubu ise sınıf eğitimine ilaveten çalışma föylerinden faydalanmıştır. İki grup arasında kimya başarı farkı olup olmadığını gözlemek- için t-testi analizi kullanılmıştır. Sonuçlar BDE'den faydalanan grubun başarısının istatistiksel olarak daha fazla olduğunu göstermiştir.

ANAHTAR SÖZCÜKLER:

Bilgisayar Destekli Eğitim (BDE), Kimya Başarısı, Çalışma Föyleri

1. INTRODUCTION

An important goal of science education is to help students develop an understanding of concepts and principles and use them when solving a problem in a new situation [1]. Students frequently find solving chemistry problems difficult. It has been found that major obstacles to solving problems in chemistry are the lack of understanding chemical concepts [2,3]. The study of the behavior of mole concept and gases has been a fundamental part of high school chemistry courses for many years. These topics include the concepts which seem to give high school students trouble, because they involve abstract and theoretical concepts. They include extremely large quantities of particles that are extremely small in nature, the students may be unable to make the connection between the representation of chemicals on the microscopic level. These concepts require the student to function at the level of formal operations such as hypothetical, proportional, probabilistic, combinatorial reasoning, and identifying and controling relevant variables. Some skills that require formal reasoning ability for solving the problems related to mole concept and gases are converting the mass of an element or compound to the number of atoms or molecules present; applying the definition of mole as it relates to the Avogadro number of atoms or molecules and to the molar mass of an element or compound; identifying and applying gas laws. The teaching style for teaching these subjects is very important as a quality of instruction. The instruction should enable students to practice learning activities in appropriate learning environment. Computers have been available for instructional use for well over two decades.. They have traditionally been used for software- interactive situations such as drill and practice, tutorials, and simulations. The computer can be a powerful tool to facilitate learning and motivate students.

Today there are quite a few concerns expressed regarding the quality or appropriateness of software for use in science courses. The literature on microcomputers and education is filled with articles by advocates claiming that microcomputers have the potential to promote more active learning, more effective and efficient learning, more individualized learning, increased student motivation, and more varied conceptual modes [4,5]. In most cases, CAI also decreases substantially the amount of time required for students to complete instruction [6,7,8].

It can be concluded that a well designed computer program can enable the student to discover the basic relationships between the properties of gases, as stated within Boyle's Law, Charles's Law, and temperature- pressure relationship, and to understand the mole concept, and then to practice solving problems. The development of new information technologies and their consistent incorporation into th

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educational system has prompted science educators to revise traditional approaches and set new priorities. Some studies showed that the students who were instructed with CAI performed at higher levels of success in mathematics or science courses than a similar group of students who were instructed with other teaching methods [9,10,11]. However, Jegede, Okebukola, and Ajewole's [12] study and Waugh's [13] study found no difference in the achievement profiles of students taught using the computer and those who were taught without the computer.

Thus, there is evidence supporting the use of CAI, but some results differ concerning achievement with CAI. Further research is needed.

2. PURPOSE

The purpose of this study was to compare the effects of the classroom lectures supplemented by CAI and by worksheet study on achievement in chemistry. For this pupose, the following hypothesis was tested:

H_0= the two modes of the instruction (CAI vs. worksheet study) have no differential effect on student achievement in chemistry.

3. METHOD

3. 1. Subjects

The subjects of the present study included tenth grade (lycee 2) students. Four high school classes of the Chemistry Course taught by two classroom teachers were randomly assigned to two modes of the instruction. Each teacher had two classes, one utilizing CAI and the other utilizing worksheeet study. The group who received CAI accompanied with the classroom instruction consisted of 62 students while the group that received the worksheet study. accompanied with the classroom instruction consisted of 57 students.

3. 2. Instruments

A 41- item, multiple- choice test was used to assess students' performance on chemistry from an initial set of 55 items after item analysis. This test was called Achievement Test of Chemistry Subjects (ATCS). The items were evaluated by the classroom teachers and a group of experts in chemistry and science education according to the appropriateness of the items for the purpose of the investigation and their representetiveness of high school chemistry. An internal consistency reliability of 0.86 was obtained in this study. The following two items exemplify the kind of problems included on test:

Which one of the following oxides contains 0.6 moles of oxygen atoms in 15.2 g of the compouns?

(At. Wt. X: 14; O: 16)

a) XO b) XO_2 c) $X_2 O_5$

d) $X_2 O_3$ e) X_2O

NH3 is decomposed into nitrogen and hydrogen. What is the volume of produced hydrogen gas at STP?

a) 1 lt b) 3.36 lt c)4.44 lt

d) 2.56 lt e) 8.60 lt

Logical Thinking Ability test (LTAT) originally developed by Tobin and Capie [14] was given to all groups at the begining of the treatment to control their formal reasoning levels. This test is a group paper and pencil test consisting of 10 items based on five reasoning modes (identifying and controling variables, proportional reasoning, correlational reasoning, probabilistic reasoning, and combinatorial reasoning). The reliability coefficient for LTAT measure used in this study was 0.79.

3.3. Procedure

This study was conducted over approximately 5 weeks.Four chemistry classess in a high school were randomly assigned to two treatment groups, experimental and control. The experimental group used a specific computer software accompanied with the classroom instruction, while the control group used the worksheets accompanied with the regular classroom instruction.

This study was done using a pretest- posttest control group design [15] with Achievement Test of Chemistry Subjects. Logical Thinking Ability Test was given at the beginning of the treatment to determine whether there would be a significant difference between the groups with respect to reasoning ability.

The classroom instruction was given by the respective class teachers. The CAI and worksheet study were taught by the same person, who had experience in CAI and worksheet study. The topics investigated in the classroom treatment, CAI, and worksheet studies were the same (the mole concept and gases). The classroom instruction of the groups were two 45-minute session per week. The teacher- directed strategy represented the customary approach used in the chemistry course. The classroom teachers provided instruction through lectures and through discussion.

In the worksheet sessions, the worksheet consisted of one or two pages which included mathematical and conceptual questions (about eight to fifteen questions) to be answered, tables to be computed, or space for students to make sketches and graphs. These sessions took about total 7 hours during the treatment. The teacher roamed the room, acted as facilitator, and answered some questions and made suggestions when needed. Worksheets were corrected and scored, and the students investigated their sheets after correction.

The CAI group learned the same topics as the worksheet group. The students worked with the computer at the time discretion for an average of 7 hours. The terminal objectives of the lessons in the program were given. The computer was used as a presenter of the basic course material and served as a personal tutor. Each student was simply presented with the sequence of material. The aspect of individualization was the speed at which the student progressed through the sequence on his own. The program provided text material which included the basic definitions, concepts, and formulas. This was followed by the questions to check student comprehension. Problem solving is an activity that enhances students' conceptual understanding of the phenomena covered by the problem. Compared to worksheet study, computer allowed the students to solve more problems and a large variety of problems. The questions were randomly generated thruogh the program. The computer checked each step of a student's problem solution for its conceptual validity and computational accuracy. The feedback from the computer to the student on the correctness of formulation and the computation was immediate. Each time the student entered an incorrect response, he was asked to try again or the program gave additional information that returned student to that part of the program that he failed to understand. The students were able to exit from a lesson at any point, and to re-enter any part of the program. The program also provided graphs and animations. Graphs were used to illustrate the relationship between some variables such as the relationship between pressure and temperature in the gas subject. The animated visuals were used during the instruction in which the adequate visualization of an instructional task was needed. This technique was used to explain Graham's law of diffusion and gas laws. It provided dynamic modes of instruction which are almost impossible with a textbook. An example of the computer program is given in Figure 1.

Menu Rule Example Question Hint Quit

0.6 mole X_2O_3 has a mass of 61.2 g. Find the atomic weight of X.

a) 27 b) 102' c) 6.375 d) 54 e) 51

Your answer:__

***Figure 1.** An Illustration of The Computer Program on the Screen*

4. RESULTS

This study was analyzed by t-test from SPSS/PC [16]. At the beginning of the treatment, in order to determine the differential effects due to cognitive developmental level and prior knowledge, the Logical Thinking Ability Test and Achievement Test of Chemical Subjects(ATCS) were utilized as the pretests to measure formal reasoning skills and previous background about mole concept and gases. The test results showed that there was no significant difference in formal reasoning ($t=0.16$, $df=117$, $p>0.05$) and previous learning in chemistry ($t=0.57$, $df=117$, $p>0.05$) of the two comparison groups (CAI and worksheet). The ATCS was given at the end of treatment to determine differential effects of two modes of the instruction. The means and standard deviations of pre and post measures of ATCS are shown in Table 1.

Table 1. The Means and Standard Deviations of the Pre and Posttest Results of the Achievement test of Chemistry Subjects (ATCS).

		pre-ATCS		post-ATCS	
Group	N	M	SD	M	SD
CAI	62	16.31	6.60	27.13	6.87
Worksheet	57	15.63	6.32	22.79	8.07

The result showed a significant difference between CAI group and worksheet group for the posttest measure of ATCS. The CAI group scored significantly higher than the worksheet group with respect to achievement in chemistry ($t=3.16$, $df=117$, $p<0.05$).

5. DISCUSSION

The results indicated that the CAI had a significant advantage over the worksheet study in the improvement of achievement in chemistry subjects. The program provided an organized study with appropriate repetition. The students got immediate feedback on answers while interacting with one other. The students in CAI might have understood the concepts and problems better because the computer program enabled them to solve more problems and a variety of problems. More meaningful learning is possible if appropriate questions are asked.

The computer program used coloured graphical displays and animations, but the worksheet instruction did not. Coloured graphical displays could illustrate concepts far more elegantly than the classroom teachers who could draw on the blackboard. The visualization of the object's movement is critical to understand the concept [17]. The computer program also provided immediate feedback on errors. The students in the worksheet group utilized feedback, but it was not immediate. The immediate correction of erreneous responses may be the most important function of feedback, because eroneous information is likely to be preserved and interfere with future learning unless corrected.

Today very few science teachers are using computers regularly in their science courses. Possible causes for this are : (1) the inaccessibility of microcomputers for use within each science classroom; (2) the lack of training of both preservice and inservice science teachers in the use of content application of computers; and (3) the minimal amount of quality software in science.

The need for furter inquiry can be indicated in the search for proven effective applications of CAI in science education.

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