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Effects of Computer-Based Simulations Teaching Approach on Students' Achievement in the Learning of Chemistry among Secondary School Students in Nakuru Sub County, Kenya

Mihindo W. Jane MED (Science)* Wachanga S.W. Prof Anditi Z. O.Dr.
Department of Curriculum, Instruction and Educational Management, Egerton University, Kenya

Abstract
Science education should help develop student's interest in science as today's society depends largely on output of science and technology. Chemistry is one of the branches of science. Chemistry education helps to expand the pupil's knowledge of the universe and of his/her position in it. It helps in the appreciation and enjoyment of nature and life. Chemistry also prepares learners for professional careers in such fields as medicine, bio-technology, agriculture and pharmacy. Despite the importance attached to Chemistry, students' performance in the subject at the national examinations in many countries Kenya included has remained poor. The poor performance can be attributed to type of teaching method among others factors. Computer-based instruction may help address this problem of teaching method. However there is little information on how computer-based learning as a teaching method in chemistry would affect learners' achievement by gender. In an attempt to address this issue this study therefore aimed at finding out effects of Computer-Based Simulations on secondary schools students' achievement in Chemistry in Kenya. The study involved quasi-experimental research in which the researcher used Solomon Four Non- Equivalent Control Group Design. Four co-educational schools in Nakuru East Sub-County were purposively selected and a sample size of 175 students participated in the study. In this study data were collected using instruments Chemistry Achievement Test (CAT) to assess the students' achievement level. The findings of the study were there was statistically significant difference in Chemistry achievement of students who are taught through CBS teaching approach and that of those taught through regular teaching method. There is no statistically significant difference in Chemistry achievement between boys and girls taught through CBS teaching approach. It was therefore concluded that CBS has a positive and significant contribution to the understanding of chemistry concepts and principles as reflected by the higher performance of students taught using CBS than their counterparts taught using RTM. Gender has no effect on students' achievement in Chemistry when they are taught through CBS.
Keywords: Chemistry, Science, Computer-based Learning, Gender and Achievement

Introduction

Chemistry is one of the branches of science. Chemistry education helps to expand the pupil's knowledge of the universe and of his/her position in it. It helps in the appreciation and enjoyment of nature and life. Also, it prepares learners for professional careers in such fields as medicine, bio-technology, agriculture and pharmacy. According to Jegede (2007), it is a core subject for medical science, textile science, printing technology and chemical technology. Therefore, the essence of appropriate conception of concepts related to Chemistry is of a very great significance because the subject is very important to science and technology. Being a science, chemistry learning therefore requires active construction of the knowledge that makes sense to new experiences. This would enable students to apply knowledge in performing activities in which scientists engage to describe, explain, predict and control the world around them (Okere, 1996). Furthermore, Okere cites it is an important subject in choice of career in university. Chemistry education is useful in understanding issues of life that affect people. It is therefore necessary to understand as a minimum the simpler words and definitions in Chemistry.

Despite the importance attached to Chemistry, students' performance in the subject at the national examinations in many countries has remained poor. According to Trends in International Mathematics and Science Study ([TIMSS], 2011) 56 countries and other education systems administered TIMSS at grade eight. Less than half of the countries which participated had an average scale score of below 500. Scores on the TIMSS mathematics and science tests range from 0-1000. Both tests have an average scale score of 500, with a standard deviation of 100. Morocco, Indonesia, Lebanon and Ghana participated in the TIMSS 2011 but their scale scores were below average. According to Ogunniyi (2001) the overall performance of school Chemistry in developing countries is generally weak.

In Kenya despite the importance attached to Chemistry, the students' examination results in the subject in Kenya Certificate of Secondary Education (KCSE) have remained poor (KNEC, 2013). Kenya National Examinations Council (KNEC) Report 2014 also showed continued decline in performance in chemistry. In addition mean score in percentage was higher for boys than that of girls. The poor performance in Chemistry has raised an outcry from parents. A major factor that may contribute to such a situation is the approach in the teaching of chemistry subject. When the teaching method is inappropriate for the level of students the effect is

likely to be fear of the sciences. In Kenya, Chemistry is a compulsory subject in the first two years of the secondary school. The chemistry syllabus as provided by Kenya Institute of Curriculum Development (KICD) emphasizes teaching through experimentation (KIE, 2002). However the teaching of the subject has continued to be expository which has contributed to poor performance (Wachanga, 2002). Effective science learning depends on the method and techniques employed by the teachers during instruction. According to Wambugu (2006) the teaching approach that a teacher adopts is a factor that may affect students' achievement. The Regular Teaching Methods (RTM) mostly being used to teach Chemistry are expository in nature. These methods leave little room for the students to think and be creative (Ndekei, 2011). Teaching methods need to be improved and appropriate teaching strategies developed depending on situation. In addition it is important to note that different topics in Chemistry may require different approaches depending on their complexity and structure(Wachanga,Chebii&Kiboss, 2005). Chemistry practical lessons involve use of chemicals that cost a lot of money.

Computer-Assisted Instruction (CAI) is one that has been lauded as able to teach concepts that are either difficult or dangerous (Allesi&Trollip, 2001). CAI programmes are categorized into drills and practice, simulations or hypermedia. Computer-Based Simulations (CBS) is able to present certain dynamic and complex concepts that are extremely difficult to explain using words, equations or class experiments. CBS with animated colour and graphic images is capable of presenting the dynamic nature of the process of electrolysis through a multi-sensory approach that lacks in the regular methods. The process of electrolysis may therefore greatly benefit from the use of computer-assisted instruction because the process does manifest itself visibly. Also, the use of computer-based simulations may save some money by reductionif regular teaching methods are used in teaching science subjects, students understand subject at knowledge level and they usually memorize the science concepts without understanding the real meaning. As a result they do not conceptualize the science concepts well as intended (Wesi, 2011). Such factors influence student's attitude, cognitive development and achievement in science and science education. It is known that it is not easy to eliminate misconceptions by just employing regular instructional methods. One of the ways to overcome this problem is to try to develop and use computer-assisted instruction.CBS plays an important role in contemporary teaching and learning of science concepts (Chang, 2009). Computers can be used as a supplementary tool in order to achieve educational goals. It is reported that student abilities and skills are affected positively by use of computers (Bayraktar, 2000). It is also stated that the use of computers makes students feel confident and helps them to discover interactions among the components of a complex system (Ramjus, 1990). In addition most of the knowledge related to natural phenomenon is available in computers, hence students can be able to visualize the physical phenomena in a three dimensional form (Shamai, 2001). If CBS materials are developed and implemented in an effective way student's achievement and affinity increases in science lessons (Lee, 2001). Integration of computers in chemistry classrooms can provide an effective learning environment for students to enhance their chemistry skills by engaging them with "real world" conditions to make the abstract concepts concrete and clear. In this way students can have a meaningful and retentive learning and they will be much more ready for their future education life such as university education or their professional life. The CBS environment provides a platform to apply the knowledge in a given situation and their interactions results in the discovery of new knowledge that will help cognitive domain development and the accumulation of knowledge (Shamai, 2001). This study was designed to investigate the effects of computer-based classroom experiments on students' achievement in the learning of chemistry by gender among secondary school students in Nakuru sub county, Kenya.

Objectives of the study

The following were the specific objectives of this study:

a) To compare the achievement of secondary school students who are taught Chemistry through CBS and those taught through RTM.
b) To find out whether there are gender differences in achievement of students taught through CBS teaching approach.

Hypotheses of the study

In this study, the following null hypotheses were tested;

H_o1: There is no statistically significant difference in secondary school students' chemistry achievement scores between those taught through CBS and those taught through RTM.

H_o3: There is no statistically significant difference in chemistry achievement of male and female students who are taught through CBS teaching approach.

METHOD

Research Design

The study involved quasi-experimental research in which the researcher used Solomon Four Non- Equivalent

Control Group Design. The design is considered rigorous enough for experimental and quasi-experimental studies. The secondary school classes once constituted exist as intact groups and school authorities do not allow such classes to be broken up and reconstituted. The research design may be represented in Figure 1;

E1	O_1	X	O_2
C1	O_3	_	O_4
E2	_	X	O_5
C2	_	_	O_6

Figure 1: Solomon Four Non-Equivalent Control Group Research Design

Key

O_1 and O_3 are pre-tests

O_2, O_4, O_5, and O_6 are post- tests

X is the treatment where students learn through CBS

Experimental Groups E1 and E2, Control Groups C1 and C2

Sample and Sampling Procedure

A total of 175 students participated in the study. Purposive sampling was used to select participating schools. The unit of sampling was the schools rather than individual learners because secondary schools operate as intact groups. Each school provided the Form Two class to participate in the study. Simple random sampling was used to select the stream for purposes of data analysis if the school had more than one stream for a Form Two class. According to the Ministry of Education regulations, the average number of students in Kenyan secondary school classes is 45, so both the experimental and control groups were made of an average class size of 45 each.

Instrumentation

The research instrument used in the study was Chemistry Achievement Test (CAT) to assess the students' achievement level**.** The researcher also developed a teachers' manual which was used to train teachers in the experimental schools. The CAT was aimed at assessing the learners' knowledge and understanding of chemistry concepts. It was developed by the researcher based on past Kenya Certificate of Secondary Education (KCSE) papers. The CAT had 12 structured short answer questions with a total of 50 marks to test the achievement level on the chemistry topic electrolysis. The items in the instrument were structured in such a way as to start with those of low order thinking and progressive move to more complex ones. The concepts, skills and principles measured included:

a) electrical conductivity in solids
b) electrical conductivity in molten substances
c) electrical conductivity in aqueous substances
d) electrolysis
e) application of electrolysis

Data analysis and interpretation

Data was analysed using inferential statistics; to test for differences between the control and experimental groups. Analysis of variance (ANOVA) and analysis of covariance (ANCOVA) was used. ANOVA was used to determine if the control and experimental groups differ significantly among themselves on treatment. ANCOVA was used to level out differences among the groups. To test for differences between the pre-test mean scores for Experimental Group E1 and the Control Group C1, t–test was used. A t-test was also used to test on gender differences in achievement and self-concept. To make reliable inferences from the data, all statistical tests were tested for significance at alpha level at 0.05.

Results of the Pre-test

The research design employed in this study allowed the use of two groups to sit for pre-tests. Experimental Group1, (E1) and Control Group 1, (C1) sat for CAT and CSCQ. This arrangement was preferred because it enabled the researcher to find out the effect of pre-test on the pre-tested groups and if the groups were similar/equivalent before the administration of treatment. Table 1 shows summary on students' pre-test scores for both CAT and CSCQ.

Table 1
Summary on Students' Pre-test Scores on CAT

Variable	Group	N	Mean	Std Deviation	Std Error of the Mean
C A T	E 1	43	. 3637	. 07241	. 01104
	C1	43	. 3856	. 06723	. 01025

The mean values for CAT was calculated out of a possible 1 mark. The results in Table 5 show that the Control Group had a greater mean than the Experimental Group. To test whether there was any significant difference in the two means for CAT an independent t-test was performed and the results are presented in Table 2.

Table 2
Independent Samples t-test of the Pre-test Mean Scores on CAT

		Levene's Test for Equality of Variances		t-test for equality of means				
Variable		F	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std Error Difference
CAT	Equal variances assumed	2.011	.160	-1.451	84	.151	-.02186	.01507
	Equal Variances Not assumed			-1.451	83.543	.151	-.02186	.01507

df = 84, t-critical =1.984, p<0.05

An examination of Table 2 shows that the mean scores of Experimental Group 1 and Control Group 1 are not statically significantly different since t(84)= -1.451, p> 0.05.This means that the groups used in the study exhibited comparable characteristics. The groups were therefore regarded suitable for the study.Table 3 shows summary of the students' CAT pre-test scores by gender for Experimental Group1.

Table 3
Summary on Students' Pre-test Scores on CAT based on Gender

Variable	Gender	N	Mean	Std Deviation	Std Error Mean
CAT	Female	22	. 3818	. 07682	. 01638
	Male	21	.3448	.06385	.01393

Table 3 shows that the means for female students compared closely with that of male students in the CAT. To test whether there was any significant difference in the two means for CAT an independent t-test was performed and the results are presented in Table 4.

Table 4
Independent Samples t-test of the Pre-test Mean Scores on CAT based on Gender for Experimental Group 1.

		Levene's Test for Equality of Variances		t-test for equality of means				
Variable		F	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std Error Difference
CAT	Equal variances assumed	.220	.642	1.716	41	.094	.03706	.02160
	Equal Variances Not assumed			1.723	40.255	.092	.03706	.02150

df = 41, t-critical = 2.00, p<0.05

An examination of Table 4 shows that the mean scores of female and male students are not statically significantly different since t(41)= 1.716, p> 0.05.This means that the groups used in the study exhibited comparable characteristics.

Effects of CBS on Students' Achievement in Chemistry

To determine the effects of using CBS teaching approach on students' achievement in Chemistry, the analysis of post-test CAT means scores was carried out. Hypothesis one, H_O1 was derived from objective one of the research study and it stated that there is no statistically significant difference in Chemistry achievement of students who are taught through CBS and those that were not exposed to it. To test this hypothesis the analysis of post-test CAT means scores was carried out. The mean scores of the four groups are shown in Table 5.

Table 5
CAT Post- test Mean Scores Obtained by the Students in the Four Groups

Group	N	Mean	Std Deviation
Experimental Group1	43	.6870	.15143
Control Group 1	43	.5135	.16720
Experimental Group 2	44	.6200	.13147
Control Group 2	45	.5480	.20584
Total	175	.5918	.17810

The means of the four Groups were different. The mean scores of Experimental Groups 1 and 2 were higher than those of Control Groups 1 and 2. This could be due to their exposure to CBS. Table 5 shows higher mean score for Experimental Group 2 compared to Control Group 2, both Groups were not pre-tested, though Experimental Group 2 received treatment. It can be deduced that the treatment CBS had a positive effect on the achievement of the students in Experimental Group 2 as well. If there was any pre-test effect on the pre-tested Groups then the posttest means of Experimental Group 1 and Control Group 1 would be much higher than the Experimental Group 2 and Control Group 2. Similarly if there was an interaction between the pre-test and treatment condition, the post- test mean scores for the Experimental Groups and the Control Groups should have indicated greater difference due to the pre-test sensitization. A comparison of the post-test results of the two sets of groups did not show any interaction between the pre-test and the CBS.

Table 6 shows the outcome of one way Analysis of Variance (ANOVA) based on the post-test mean scores on the CAT. This was to find out whether the difference in the mean scores was statistically significant.

Table 6
Analysis of Variance (ANOVA) of the Post-test Mean Scores on the CAT

	Sum of Squares	df	Mean Squares	F	Sig
Between Groups	. 775	3	.258	9.305	.000
Within Groups	4.745	171	.028		
Total	5.519	175			

F-critical = 2.60, $p<0.05$

The results in Table 6 show that the difference between and within groups is statistically significant $F(3,171) = 9.305$, $p< 0.05$, leading to the rejection of H_o1.Since there was statistically significant difference between the means of the groups; it was necessary to carry out post-hoc comparisons test of CAT mean scores to establish where the differences occurred. The tests were carried out using Bonferroni procedure, at $P<0.05$.Bonferroni analysis was preferred for this study because it controls for the overall error rate hence the observed significance level is adjusted for the fact that multiple comparisons were being made. Whenever there is a significant difference between the means of different groups, this test in particular shows where the differences occurred. The results of Bonferroni post –hoc comparisons of CAT mean scores are shown on Table 7.

Table 7
Post Hoc Comparisons of the Post-test of CAT Mean Scores for the four Groups

(I) Group	(J) Group	Mean Differences(I-J)	Std Error	Sig
E1	C1	.17349	.03592	.000
	E2	.06698	.03572	.375
	C2	.13898	.03552	.001
C1	E1	-.17349	.03592	.000
	E2	-.10651	.03572	.020
	C2	-.03451	.03552	1.000
E2	E1	-.06698	.03572	.375
	C1	.10651	.03572	.020
	C2	.07200	.03532	.258
C2	E1	-.13898	.03552	.001
	C1	.03451	.03552	1.000
	E2	-.07200	.03532	.258

* the mean difference is significant at the 0.05 level

The post-hoc comparisons showed that the mean differences between Experimental Group 1 and Control Group1, Experimental 1 and Control Group 2, Control Group1 and Experimental Group 2 were statistically significant different at $p< 0.05$ level. However the mean differences between Experimental Groups 1 and 2 and Control Groups 1 and 2 were not statistically significant. It is important to note that the mean difference between Experimental Group 2 and Control Group 2 was not statistically significant. This could be due to the fact that probably because the students in Control Group 2 were more enthusiastic, interested and self-motivated to learn Chemistry. Since the Experimental Groups 1 and 2 received treatment, the results of the post-

hoc comparisons confirmed that CBS had a positive effect on students' achievement in Chemistry, thus leading to the rejection of the null hypothesis (H_o1).

Since this study engaged non-equivalent control Group design, which involved intact groups in the exercise, it is possible that the statistically significant differences shown on the post-test mean scores of the groups could have resulted from the pre-existing group differences other than the treatment effect. Therefore it was necessary to confirm the above results by carrying out analysis of covariance test (ANCOVA) to adjust the post-test mean scores of the groups using the students' Kenya Certificate of Primary Education (KCPE) as covariates in an attempt to reduce the effect of the initial group differences statistically by making compensating adjustments to the post-test means of the groups involved (Gall et al., 2007). Table 8 shows the adjusted CAT post-test mean scores for ANCOVA using KCPE as covariate.

Table 8

Adjusted CAT post-test mean scores for ANCOVA with KCPE as Covariates.

Groups	N	Actual Mean	Adjusted Mean
Experimental Group 1	43	.6870	.686[a]
Control Group 1	43	.5135	.514[a]
Experimental Group 2	44	.6200	.621[a]
Control Group 2	45	.5480	.547[a]

a covariates appearing in the model are evaluated at the following: KCPE Marks= 279.5314

The adjusted CAT post-test mean scores with KCPE as covariate for the four groups were similar to the CAT post-test mean scores before adjustment. This showed that an attempt to readjust the mean scores by introducing a covariate did not cause any change on the post-test mean scores of the four groups. When the post-test mean scores of the pre-tested pair group were compared to the groups that were not pre-tested, the outcome showed that the groups that received treatment had better mean scores over the control groups despite Control Group 1being pre-tested. This suggested that the pre-test did not influence the achievement of the students who were pre-tested. The results of the adjusted means enabled an analysis of covariance to be done and the results are shown in Table 9.

Table 9

ANCOVA of the post-test Scores on the CAT

Dependent variable: Chemistry Achievement

Source	Type III Sum of Squares	df	Mean Squares	F	Sig.	Partial Eta Squared
Corrected Model	.782[a]	4	.195	7.013	.000	.142
Intercept	.650	1	.650	23.315	.000	.121
KCPE	.007	1	.007	.259	.611	.002
Groups	.772	3	.257	9.238	.000	.140
Error	4.738	170	.028			
Total	66.803	175				
Corrected Total	5.519	174				

a. R squared= .142(Adjusted R squared= .121)

The results in Table 9 shows that there was still statistically significant difference F (3,170) = 9.238, $p<0.05$. To establish where the differences were located, another Bonferroni post-hoc pairwise comparison based on ANCOVA was carried out and the results shown in Table 10.

Table 10

ANCOVA Pair-wise Comparisons on CAT Mean Scores for the Four Groups

(I) Group	(J) Group	Mean Differences(I-J)	Std Error	Sig.(a)
E 1	C 1	. 1 7 2	. 036	. 000
	E2	.065	.036	.071
	C2	.139	.036	. 000
C1	E1	-.172	.036	.000
	E2	-.107	.036	.003
	C2	-.033	.036	.352
E2	E1	-.065	.036	. 071
	C1	.107	.036	.003
	C2	.074	.036	.040
C2	E1	-.139	.036	.000
	C1	.033	.036	.352
	E2	-.074	.036	.040

*, The mean difference is significant at $p<0.05$ level

The post-hoc pair-wise comparison based on ANCOVA show statistically significant difference

between Experimental Group 1 and Control Group 1 and 2, similarly the same was observed between Experimental Group 2 and Control Group 1 and 2.These results are supported by the data in Table 11, which show that the mean scores of Experimental Groups are higher than that of Control Groups. The results of ANCOVA pair wise comparisons relate very closely to that of post-hoc ANOVA. This confirms that the CBS employed in the study had an effect on the students' achievement in Chemistry as compared to the regular teaching approach used on the control groups. Therefore hypothesis H_o1, which stated that there is no statistically significant difference between students' exposed to CBS and those taught using RTM, is rejected**.**

A comparison of the CAT pre-test and post-test mean scores between E1 and C1 was carried out. Table 11 shows comparison of the mean scores of CAT in the Pre-test and Post-test and also the mean gained by the students.

Table 11

Comparison of the Mean Scores and Mean Gain by Students' in CAT

	Overall N=86	Experimental Grp1 N=43	Control Group1 N=43
Pre-test Mean	.3747	.3637	.3856
Post-test Mean	.6003	.6870	.5135
Mean Gain	.2256	.3233	.1279

Table 11 shows that there was a higher mean gain obtained by Experimental Group 1 than by Control Group 1. Since the students' in Experimental Group1 were exposed to CBS, it is reasonable to infer that CBS had a positive effect on students' achievement in Chemistry. However, it is important to note that both groups gained from the respective teaching approaches but the group which was exposed to CBS had a higher gain than the group that followed the regular teaching approach.

Effects of CBS on Gender Differences in Achievement

The determination of the effect of using CBS teaching approach on gender differences in achievement was guided by hypothesis three, H_o3 of the study which sought to find out whether there was statistically significant difference in chemistry achievement of male and female students who are taught through CBS teaching approach. Table 12 shows summary of the post-test mean scores of both CAT and CSCQ for the Experimental Groups 1 and 2 based on Gender.

Table 12

Summary on Students' Post-test Scores on CAT and CSCQ based on Gender

Variable	Gender	N	Mean	Std Deviation	Std Error Mean
CAT	Female	38	.6432	.15433	.02504
	Male	49	.6608	.13814	.01973

The results in Table 12 show that the mean for male students was higher than their female counterparts for CAT. Table 13 shows the t-test of the post-test mean scores on CAT based on students' gender for Experimental Groups 1 and 2

Table 13

Independent Samples t-test of the Post-test Mean Scores on CAT based on Students' Gender.

		Levene's Test for Equality of Variances		t-test for equality of means				
Variable		F	Sig.	t	df	Sig (2-tailed)	Mean Difference	Std Error Difference
CAT	Equal variances assumed	.003	.954	-.562	85	.576	-.01766	.03143
	Equal Variances Not assumed			-.554	74.954	.581	-.01766	.03188

df = 85, t-critical= 1.984, $p< 0.05$

From the results of the independent samples t-test no significance difference was obtained between achievement of male and female who were taught Chemistry through CBS since t (85) =-.562, $p>0.05$. Consequently, the null hypothesis, H_O3 was accepted.

Since this study involved non-equivalent control group design, it was necessary to carry out analysis of covariance with KCPE as covariate, to compensate for the differences exhibited in the mean scores of the male and female students at the pre-test level. Table 14 shows the adjusted post-test mean scores of CAT based on gender for the Experimental Groups.

Table 14

Adjusted Post-test Mean Scores of CAT based on Gender for Experimental Groups1and 2

Gender	N	Actual Mean	Adjusted Mean	Std error
Female	38	.6432	.642[a]	.024
Male	49	.6608	.661[a]	.021

a. Covariates appearing in the model are evaluated using KCPE marks = 280.3448

The adjusted CAT post-test mean scores of male and female students in the ANCOVA showed that male students performed better than their female counterparts. The results of the adjusted means enabled an analysis of covariance to be done and the results are shown in Table 15.

Table 15

ANCOVA of the Post-test CAT Mean Scores based on Gender for Experimental Groups

Dependent variable: Achievement on Gender

Source	Type III Sum of Squares	df	Mean Squares	F	Sig.	Partial Eta Squared
Corrected Model	.012[a]	2	.006	.278	.758	.007
Intercept	.383	1	.383	17.954	.000	.176
KCPE	.005	1	.005	.243	.623	.003
Gender	.008	1	.008	.355	.553	.004
Error	1.792	84	.021			
Total	38.913	87				
Corrected Total	1.804	86				

a. R squared = .007 (Adjusted R squared= -.017)

The results in Table 15 showed that there was still no statistically significant difference between the mean scores of male and female students in Experimental Groups 1 and 2,$F(1, 84) = .355$,$p > 0.05$. Therefore, $H_0 3$ is accepted.

Gender differences in Science have long been discussed among researchers. The findings of this study were consistent with previous research results. Research has demonstrated a decline in gender differences in science performance; however, female representation in science-related fields is still low (Jacobs, 2005).

Discussion of results

The following section presents a discussion of the results based on the pre-test and the two hypotheses.

a) **Results of the Pre-tests**

Pre-tests were administered to evaluate achievement in and self-concept towards Chemistry. After the pre-test, students in the experimental groups were taught using CBS module while the control groups were taught using the regular teaching method. The use of a pre-test enabled the researcher to evaluate the similarity of the treatment and control groups prior to treatment.

The results indicate that there was no significant difference in the post-test mean scores between Experimental Groups 1 and 2 and also Control Groups 1and 2. The post-test results in this study did not indicate any interaction between the pre-test and the instructional intervention. If the pre-test provided a practice effect it would result in higher post-test performance by groups receiving the pre-test. A comparison of the post-test results of the four Groups does not indicate that the pre-test provided a practice effect. When the results of the pre-test CAT mean scores for Experimental Group 1and Control group 1were compared, they revealed that there was no significant difference. Similarly the results of the pre-test CAT mean scores for only Experimental Group 1 on female and male students were compared, they revealed that there was no significant difference. These results show that the Groups were similar before the administration of the treatment.

b) Effect of CBS on Students' Achievement

The findings of this study indicate that the students in the Experimental Groups attained significantly higher scores in Chemistry than did the students in the Control Groups. This implies that CBS module is more effective in enhancing students' achievement than regular teaching methods. Studies carried out by Opara (2011) showed that computer assisted teaching and learning was more effective than the regular teacher centred methods to increase academic achievement.

Ragasa (2010) in his research on a comparison of computer-assisted instruction and the traditional method of teaching basic statistics showed that combination of computer-assisted instruction and collaborative work improved learning. He also found out that computer-assisted learning served to establish more effective learning situations than traditional teaching methods which involved teacher presentation, question and answer technique and discussion. Kiboss and Ogunniyi (2005) studied the effectiveness of a computer-Augmented Physics program on teaching the topic of measurement to first year secondary students. The results showed that the mean gains of the students in the program were significantly higher than those of their counterparts in the regular program.

Mwei, Too and Wando (2011) investigated the effects of computer-assisted instruction (CAI) on students' attitude and achievement in matrices and transformations in mathematics and reported a higher achievement with CAI treatment groups. Kiboss, Wekesa and Ndirangu (2006) research findings on the effects of a computer-based instruction program developed for the teaching of cell theory in secondary school biology showed that the CAI program resulted in significant learning gains. The study further suggested that the innovation has major implications for improving those areas of science that are difficult to teach and learn using the regular teaching methods. Serin (2011) conducted a study to investigate the effects of the computer-based instruction on achievement and problem solving skills of science and technology students. The findings of the study indicate that the use of the interactive learning packages assist learners in increasing their achievement and developing their problem solving skills.

Wanjala (2007) indicated that students learning with computer –assisted instruction in cooperative groups performed better than those learning individually. Liao (2010) found out that CBI had a positive effect on individuals by comparing research studies carried out in Taiwan in his meta-analysis study. The findings of this study concur with the findings of other studies in regard to use of computer simulations in learning. Hykle (2011) studied the relationships among gender and science content achievement and found out that computer-assisted instruction for science teaching had a higher achievement. Feyzioglu (2009) reported that the useof computer-based instructional program that involve the students more actively in the learning process often result in higher academic achievement than those that put them in a passive role. Therefore the findings of the study have proven that the CBS module was useful and might be one solution to the difficulties that teachers often experience with regular method.

The findings showed that CBS had an effect that led to improvement of performance in the subject as compared to RTM.CBS has a positive and significant contribution to the understanding of chemistry concepts as reflected by the higher performance of the experimental groups. Therefore, this study gives support to the fact that achievement of students in Chemistry could be greatly improved if they are exposed to CBS teaching approach. This implies that the use of CBS teaching approach if enhanced will reduce rote learning and can be used to emphasize student centred activities. The use of CBS will promote meaningful learning among students and raise their levels of chemistry content achievement.

c) **Effect of CBS on Gender Differences in Achievement**

The t-test results showed no significant difference in the mean scores of female and male students in Experimental Group 1. The post-test mean scores on CAT in the Experimental Groups showed no significant difference at $p<0.05$. The results from ANCOVA showed that there was no gender difference in achievement between female and male students taught using CBS. The null hypothesis (Ho3) was therefore accepted at0.05 significance level. Other research studies have reported findings which concur with the results of this study.

Helgeson and Kumar (2000) who studied the effect of gender on computer-based chemistry problem solving did not find any significant differences between male and female high school students solving stoichiometric chemistry problems through the computer. They attributed increase in student achievement in computer-based science tasks to the availability of immediate feedback which might have contributed to narrowing any gender gaps. They further note that the quality of feedback has an effect on the self-confidence of females and consequently in the science learning tasks. According to Fraser and Walberg (2005) new technologies enhanced student's performance and motivation. For science education specifically simulations, micro-computer based-laboratories and databases are said to be important for facilitating mastery of science concepts and science process skills.

Wachanga and Mwangi (2004) investigated the effects of Cooperative Class Experiment teaching method and found out that gender had no effect on the students' achievement as compared to other teaching methods. Oludipe (2012) carried out a study to investigate the influence of gender on secondary students' academic achievement in basic sciences using cooperative teaching-learning strategy. His findings revealed that there was no significant difference in academic achievement of male and female students. Kaushik and Rani (2005) found no significance difference between boys and girls with regard to achievement level. A study carried out by Abungu (2014) indicated that boys and girls exposed to science process skills teaching approach show no significant difference in Chemistry achievement. Keter (2014) carried out a study on Cooperative Mastery Learning Approach (CMLA). The results showed no significance difference between boys and girls and that CMLA is beneficial to both boys and girls. A study carried out by Olatoye, Aderogba and Aanu (2011) in Nigeria on students' achievement in organic chemistry showed no significance difference between the achievement of boys and girls. The research on gender differences in achievement for males and females has resulted in inconsistent findings. Some researchers have found have found differences Vermeer, Boekarts and Seegers, 2000, Shaibu and Marri (1997) and Ahiakwo (1988) findings showed that girls performed better than the boys in Chemistry. Opara (2011) found out that boys performed better than the girls in Chemistry and Biology. The results of a study carried out by Nyakan (2008) in Kenya revealed that there was significant difference between the performance of boys and girls in Physics.

The findings of this study have indicated that boys and girls exposed to CBS teaching approach show no significant difference in chemistry achievement and this could be due to the free interaction between male and female students in district co-educational schools. Weak students benefit from interaction with brighter students and when bright students explain their ideas to others, they learn the material they are explaining in more depth and remember it longer (Wachanga, 2002). In general, the use of CBS teaching approach is gender friendly and is an effective instructional strategy of bridging the gender gap in chemistry achievement. When girls' performance in Chemistry at the secondary school level is equally good as that of the boys then that good achievement will act as a predictor of choice of science related courses at the university which have been mainly male preserve (Abungu, 2014).

This information discredits the notion of male dominance in science learning and the view that science careers being predominantly male preserve. This implies that the use of CBS in teaching Chemistry will help in improving students' achievement in Chemistry irrespective of their gender.

Conclusion

On the basis of the findings of this study, the researcher made a number of conclusions in relation to the four hypotheses of the study. These conclusions include:

i. CBS has a positive and significant contribution to the understanding of chemistry concepts and principles as reflected by the higher performance of students taught using CBS than their counterparts taught using RTM.
ii. Gender has no effect on students' achievement in Chemistry when they are taught through CBS.

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