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COMPUTER ASSISTED LEARNING AND ITS EFFECT ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN CHEMISTRY, CASE OF MAKUENI COUNTY, KENYA

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ABSTRACT

This study investigated the impact of Computer Assisted Learning (CAL) on students' achievement in Chemistry in public secondary schools in Mbooni East Sub-County, Makueni County, Kenya. The study was guided by the following objectives: determine the difference in achievement in Chemical Bonding between learners introduced to CAL and those taught using conventional methods (CM), establish the gender effect on achievement of learners introduced to CAL, determine the perceptions of learners towards CAL and determine the perceptions of teachers of Chemistry towards CAL. Quasi-experimental design was used in which 180 Form 2 students and 4 Chemistry teachers who administered the treatment in the 4 selected schools with ICT infrastructure participated. The 4 selected schools were categorized either as control or experimental groups, 2 in each case. The experimental group was introduced to CAL using Computer instructional materials developed by Computers for Schools Kenya (CFSK) for 3 weeks while the control group was taught using CM. Data collection was done using Pre-test Chemistry Achievement Test (PRCAT), Post-test Chemistry Achievement Test (POCAT), Learners' motivational scale and teachers' interview schedule. Quantitative data was analyzed using both descriptive and inferential statistics in the form of means and t-test. Qualitative data was analyzed using Frequency distribution, means, Chi-square and thematic approach, where the results from Chemistry teachers' interviews were organized into themes consistent with the study objectives. The findings showed that there was a significant difference in achievement between the students in the control and experimental group ($p= 0.001<0.05$). However, gender was found to have insignificant influence on the CAL strategy to teaching and learning of Chemistry ($p=0.927>0.05$) therefore both boys and girls benefit equally when taught using CAL. The use of CAL was also reported by the majority of learners to be enjoyable making learning of abstract concepts easy. The teachers perceived the use of CAL to be a better alternative instructional method with the potential to improve student performance compared to conventional methods. Following the findings, the study recommended intensive application of CAL in the classroom instruction due to the advantage it offers over conventional methods in improving learners' performance.

Keywords: *Chemical Bonding, Computer Assisted Learning, Chemistry Teachers*

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INTRODUCTION

The role of Information and Communication Technologies (ICTs) in instruction has increasingly become prominent, due to the potential value of such technologies as tools for learning (Gill & Dalgarno, 2008; Oladosu, 2012). ICT integration in teaching and learning process has been encouraged because of the need to equip learners with skills and knowledge to participate and thrive in an informed society; the need to create highly skilled workforce (Atsumbe, et al. 2012); the potential for enhancement of the quality of the learning experience and transformation of pedagogy (Oladosu, 2012)

ICT integration in teaching has become essential since it assists students in developing their ability to learn and also to develop transversal knowledge that stimulates self-reliance, social skills, sense of responsibility, problem solving skills and their ability to innovate. These are some of the core values needed by a student in order to achieve excellence in any learning atmosphere (Ghavifekr, et al. 2014). Different stakeholders have continued to urge the education sector to introduce ICT integration into different levels of education, considering the speed at which different countries are being transformed into knowledge-based societies in which technology use has become an important aspect of competence (Mocanu & Deaconu, 2017).

Computer assisted learning (CAL) is one of the ICT tools that have been shown to have great potential as instructional tools in the classroom. It is a method which uses a computer as a learning media to strengthen students' motivation, give opportunities to both students to learn by their own speed and combine active learning with computer technology (Akçay, et al. 2006). According to Gonzalez and Birch (2000), CAL has the ability to promote active learning in a wide variety of disciplines from literature to the social sciences and beyond. Similarly, Jonassen (2000) describes CAL as an ICT tool that support learning by allowing students to construct knowledge, explore and assess information with other students particularly in science subjects such as chemistry

The Government of Kenya appreciates the fact that ICT contributes positively in navigating the nation towards being a middle level economy according to the Vision 2030. The journey to introduce ICT integration in schools was initially started through the introduction of Sessional Paper No.1 of 2005 (Government of Kenya, 2005) where ICT was given recognition as a prominent tool in education. This was intended to ensure that public secondary schools in Kenya are equipped with the necessary ICT resources and infrastructure. Moreover, the Government of Kenya came up with the National ICT Policy and the Government Strategy which gave direction on transforming the country into a society that embraced digitization (Government of Kenya, 2006). However, various studies attest that ICT integration in Kenya is dismal (Alma, 2014; Bitok, 2014).

Towards the realization of Kenya's Vision 2030 and attainment of Sustainable Development Goals (SDGs), the Government of Kenya (GoK) has invested heavily in education to enhance instruction (MoEST, 2015). To enhance learning of science including Chemistry, selected strategies have been adopted which include: educating teachers on learner centered methods, educating teachers on ICT integration in instruction through the agencies that work with the Ministry for teacher professional capacity development such as Kenya Education Management Institute (KEMI) and Centre for Mathematics Science and Technology Education in Africa (CEMASTEA), and digitalization of Science content (e-Content) by Kenya Institute of Curriculum Development (KICD) among others. This was done to boost learners' mastery of science concepts and building of 21st century skills for STEM jobs. Many researchers agree that proper use of ICT in teaching and learning process is capable of improving learning outcomes among students, especially in sciences (Mikre, 2011; Tedla, 2012 & ELMO, 2017).

In Kenya, Chemistry is a secondary school subject and is compulsory in Form one and Form twobut optional in Form threeand Form four. In majority of the schools, the subject is compulsory because of its importance in STEM career courses such as medicine, environmental science, engineering, pharmaceuticals and teaching among others. Chemistry as a STEM subject has been identified to play a very important role in economic growth and development of any country (Adesoju & Olantunbosun, 2008). In addition, Korpela, Moontealegre and Poulymenakou (2003) indicated that technology is a requirement for country's economic growth and

development. According to Jegede (2007), Chemistry is a vital subject to areas related to medicine and technology (printing, chemical, and textile). Under this premise therefore, better understanding of Chemistry concepts remains essential.

In Kenya, Nduati (2015) and Ogembo (2017) established that use of CAL in Chemistry instruction impacted positively on learners' performance in Murang'a County and Kwale County respectively. Both attest that learners introduced to CAL had higher scores than those taught using CM. Though evidence shows that use of CAL in Chemistry instruction impacts learners' achievement positively in various Chemistry topics, there is minimal empirical information on how it could impact learners' achievement in Structure and Bonding and this leaves a gap of knowledge. In addition, the above studies were not conducted in Makueni County. This study attempted to fill these gaps by determining the effect of CAL on learners' achievement in Structure and Bonding in government funded high schools in Makueni County.

Statement of the Problem

Integration of ICT such as CAL in teaching and learning process could be more effective and therefore can be a possible solution to improve Chemistry performance. In Kenya analysis shows that the learners' Chemistry performance in KCSE at National level and in Mbooni East Sub-County has remained low over the years which limit learners' entry to STEM careers. The low learners' achievement in Chemistry could be attributed to teachers' perception towards the ability of learners in Chemistry, insufficient resources, perception of the learners towards Chemistry and more to poor teaching approaches.

Though evidence shows that use of CAL in Chemistry instruction impacts learners' achievement positively in various Chemistry topics, there is minimal empirical information on how it could impact learners' achievement in Structure and Bonding. This study attempted to fill the gap by determining the impact of CAL on learners' performance on Structure and Bonding in government funded high Schools in Mbooni East Sub-county, Makueni County, Kenya.

Purpose of the Study

The purpose of the study was to determine how use of CAL in Chemistry instruction affect learners' achievement in the topic of Structure and Bonding in secondary schools in Mbooni East Sub-County, Makueni County, Kenya.

Objectives of the Study

The study sought to:

- Determine the difference in achievement in Structure and Bonding between learners introduced to Computer Assisted Learning (CAL) and those taught using Conventional Methods (CM).
- Establish the gender effect on achievement of learners introduced to CAL.
- Determine the perceptions of Chemistry learners towards CAL
- Determine the perceptions of teachers of Chemistry towards CAL.

Theoretical Framework

Constructivist Theory of learning guided this study. Constructivism Theory of learning entails active construction of new knowledge whereby the learner connects the new concept with the previous knowledge (Vygotsky, 1978). This theory emphasizes that learners construct new knowledge based on what they already know (Overbay, et al. 2010).

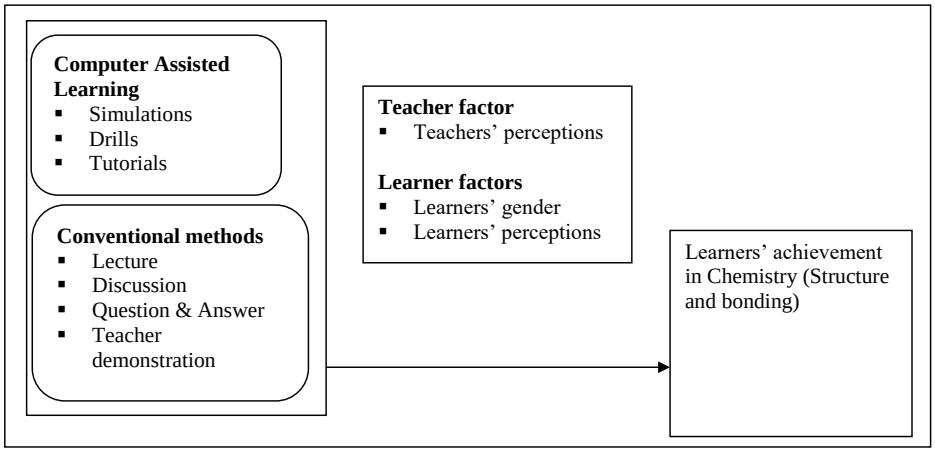
According to Kim (2005), the constructivist theory of learning holds that learning is an active process of developing meaning based on individual personal experiences and that knowledge is the personal understanding of the outside world through personal experience. This theory maintains that students get into a classroom with ideas concerning the new problem. Therefore, learning will occur because of interaction between the new

information in the learning environment and the experiences gathered due to interaction with it. It emphasizes on a learner's active involvement since knowledge is gained and lost in theory memory.

Forman and Pufall (1988) acknowledge that, Constructivist emphasizes on interactive teaching methodologies where the student is independent and the instructor assumes the role of a facilitator who provides directions to the learner. Students are able to refine their thinking by being given as many opportunities as possible and to apply their newly gained knowledge (Tien Wu & Chin–Chung Tsai 2005). Since this theory lays a lot of emphasis on the active role of the student during the time spent developing their own knowledge, when CAL strategy is utilized as a part of classroom it empowers an intelligent learning process that is learner centered. This theory also encourages student's prior knowledge as well as encourages the teacher to spend more time on student's favorite topics allowing the teacher to focus on important relevant information making students learn better in a hands-on environment. ICT such as CAL can facilitate knowledge construction through simulations (Jonassen, Howland, Moore & Marra, 2003; Mayer, 2003). Simulations link the information in the books to the learners' prior knowledge, therefore increasing stimulus variation which enhances knowledge retention.

Thus, applied to high school Chemistry instruction, constructivist approach emphasizes student's cognitive creation of chemical concepts via daily active practical involvements with a number of chemical concepts. The theory emphasizes hands-on, real-world experiences which seeks and values students' points of view. In short, the theory postulates that learning is best achieved in social contexts of content (Christie, 2005; Honebein, 1996). This theory was found fit for the study because CAL programs are interactive and thus can enable students to control the pace and sequence of their learning (Silverman & Casazza, 2000).

Conceptual Framework



Independent Variables **Control Variables** **Dependent Variable**

Figure 1: Conceptual Framework

Source: Adapted from Ogembo, 2017

The study purposed to determine the effect of use of CAL and CM on learners' achievement in Chemistry (Structure and Bonding). The study assumed that student achievement in Chemistry is dependent on teachers' instructional strategy. Anderson (2002) indicated that use of CAL can transform the way learners understand and learn concepts. CAL and CM form the independent variables while learners' achievement in Chemistry

(Structure and Bonding) is the dependent variable. The independent variable was manipulated during the study in order to determine its effect on the dependent variable. However, student achievement in Chemistry (the dependent variable) may also be influenced by other factors apart from the identified independent variable, which is, teaching strategy. These constituted the control variables, which the researcher sought to build into the study, that is, the teachers' perceptions as well as learners' gender and perceptions.

LITERATURE REVIEW

Benefits of Chemistry in Society

Chemistry as a STEM subject has been identified to play a central role in economic growth and development of any country (Adesoju & Olantunbosun, 2008). In addition, Korpela et al. (2003) indicated that technology is a requirement for country's economic growth and development. According Jegede (2007), Chemistry is a vital subject to areas related to medicine and technology (printing, chemical, and textile). Although Chemistry is core in science and technology, globally, it contributes to sustainable economic development through industry. Chemistry knowledge is significant in manufacture of food, clothing and drugs among others (Emendu, 2014). Therefore, Chemistry contributes to industrialization which promotes productivity and hence development.

Chemistry as an important subject in STEM enhances career courses such as medicine, environmental science, engineering, pharmaceuticals and teaching among others. Therefore for students to pursue such courses they must attain the expected grade in Chemistry. Low grade in the subject limits learners' entry in STEM career courses resulting to fewer students pursuing such professions. Since Chemistry has direct impact on our lives, the learners' achievement in the subject is a major concern globally (Ali et. al., 2011). Despite the importance attached to Chemistry, learners' performance in the subject at the national examinations has remained poor. This is the basis upon which the study sought to determine the effect of use of CAL on learners' Chemistry achievement in Structure and Bonding.

CAL and Teaching of Chemistry

Globally, a majority of students find Chemistry related concepts complicated and difficult to comprehend due to the teaching methodologies employed in teaching of the subject. This results to students developing a negative attitude towards the subject (Özmen, 2004). According to Ogeng'o (2012), Chemistry is perceived to be difficult by learners due to its abstract nature. Chemistry and particularly Structure and Bonding deals with materials and concepts that are more abstract than real, hence integration of ICT in teaching can concretize the concepts enhancing learners understanding. Haddad and Jurish (2002) asserted that ICTs are powerful instructional materials if integrated with interactive approaches as they motivate and engage learners in the learning process and make the abstract concept concrete for easier understanding.

Gulbahar and Guven (2008) as well as Smeets (2005) advocate for implementation of new pedagogy that would use ICT in preparing learners for work in this information age. They argue that use of ICT can provide a learning environment where learners and instructors can obtain information from various sources. Furthermore, ICT encourages collaboration where learners interact with one another as well as with their teachers. According to Barak (2007), the use of ICT such as CAL makes the abstract concepts concrete and clearer enhancing learners understanding.

The use of CAL in teaching and learning process has been considered especially for sciences and Chemistry in particular (Daintith & Wright 2008; Moore 1997). They argue that, CAL can be a powerful tool when used in teaching and learning process. Similarly Gonzalez and Birch (2000) asserted that CAL has the potential to make learning more effective. Siddiqui and Khatoon (2013) maintain that CAL and its various modes such as computer simulations and games have the ability to support new, inquiry-based approaches to science instruction, through virtual laboratories or field learning experiences. In addition CAL through simulations enhances the comprehension of abstract concepts and also provides three dimensional pictures that motivate the learners and satisfy their curiosity about scientific concepts (Agrahari & Siggh, 2013). This is supported by

Mintz (1993) who argued that CAL through simulations can concretize the abstract science related concepts including Structure and Bonding. However, there is little information on effectiveness of CAL in instruction in developing countries, Kenya included. Therefore, this study tried to determine the effect of use of CAL on learners' Chemistry achievement in secondary schools in Mbooni East Sub-County, Makueni County, Kenya.

CAL and Learners' Achievement in Chemistry

Olga (2008) established that, instructional methods used, especially those that allow learner participation greatly influence retention of knowledge and concepts taught in Chemistry. Further, Hoidn and Karkkainen (2014), indicated that different method of instructions contributed differently in student retention. On the Contrary Wynn, Mosholder and Larsen (2014) reported insignificant difference in students' knowledge retention using different methods of teaching. Retention helps in knowledge development and knowledge development can be guaranteed when effective teaching methods are employed (Eze, 2016). In addition, retention is very vital for learners to apply the concepts learnt effectively. Therefore, knowledge retention of Chemistry concepts could lead to high academic achievement in the subject.

Nyaga (2011) conducted a study to compare Computer Assisted Instruction and Conventional Instructional Techniques in Embu District, Kenya. The results revealed that learners taught through Computer Assisted Instruction attained significantly higher scores in Science than those exposed to conventional instructional techniques. Similarly Nduati (2015) investigated the effect of CAL on Chemistry achievement in Murang'a County, Kenya and the findings revealed that integration of CAL positively impacts learners' academic achievement. Results from these studies indicate positive outcome but the studies did not focus on how CAL impacts learners' achievement in Structure and Bonding hence this study sought to determine the effect of use of CAL on learners' achievement in Structure and Bonding in secondary schools in Mbooni East Sub-County.

Gender effect on Learners' Achievement in Chemistry

Gender is one of the factors affecting the performance of students in science. Nussbaum (2000) argued that conclusions on studies on gender are dissimilar. Some researchers found that male students performed better than female students (Usman 2000). Similarly, Wachanga and Mwangi (2004) observed that there is a significant difference in the performance of male and female in science. Other studies confirmed the superiority of female students' performance over male student. Yet Nussbaum found no significant difference between male and female performance. On the same note Dahiru (2004) reported that there is no significant difference between gender and selection of science subject.

Findings on influence of CAL on learners' outcome based on gender in Kenya are varied. Wanyonyi et al. (2012) in Bungoma West District found out that the performance of boys in Chemistry was significantly higher compared to the performance of girls ($F = 9.912$; $p = 0.002$), indicating gender gap in understanding of these concepts. Similarly, Muchiri (2018) in Tharaka Nithi County, indicated a significant improvement in the mean scores based on gender in favour of male students after exposure to computer assisted technique strategy. In contrast a study by Ogembo (2017) on effects of CAL on Chemistry instruction in Kwale County showed no significant difference in mean scores between the boys and girls after exposure to CAL. More researches on the influence of gender on test scores are therefore necessary. Hence this study attempted to establish how gender influences learners' achievement when taught Structure and Bonding through CAL.

Learners' Perceptions Towards CAL

Becta (2004) asserted that one of the factors that influence the utilization of ICT in instruction is the perceptions of learners and teachers towards ICT. This is in line with Selwyn (1999) who reported that the limited use of ICT in teaching and learning is attributed to the negative attitude of learners and instructors towards ICT. Therefore the effectiveness of ICT integration in instruction can be predicted by learners' perceptions towards its use. If learners perceive the use of ICT in instruction to be useful they will be more motivated in their learning. Similarly Slouti and Barton (2007) argued that application of ICT such as CAL in instruction captures the learners' attention and enhances their interest in classroom. Myers and Halpin (2002) agree that positive attitude

of learners towards integration of ICT in instruction will lead to its frequent use in the future resulting to positive impact on students' performance.

ICT integration leads to increased understanding, motivates learners and facilitates critical thinking (Ikwuka, 2010). Similarly, Halakova (2009) asserted that the motivation of students towards utilization of ICT such as CAL in learning greatly depends on its perceived usefulness. Akcay et al. (2003) investigated how use of simulations in teaching of Chemistry influences learners' achievement and perceptions. The findings showed that the performance of learners taught through simulations was better compared to that of control group. Akcay et al. added that integration of CAL in teaching and learning could be an effective method of enhancing students' motivation towards Chemistry. Similarly Ogembo (2017) found that CAL positively impact learners' attitude when used in teaching of Chemistry. The above studies were not based in Makueni County; hence this study sought to determine the perceptions of learners towards CAL in secondary schools in Mbooni East Sub-County.

Teachers' Perceptions Towards CAL

Andoh (2012) cited by Nzwili (2017) states that changes surrounding pedagogy are necessary if teachers are to be successful in implementing technology to support learning. In addition lack of sound pedagogical basis for integration of technology within the school has led to a narrow and unimaginative usage. Further Andoh argues that the focus of teachers and schools is on the use of computer classes such as ,computer studies rather than in other subject areas and thus "most studies are of the technology rather than with the technology". This has led to limited use of ICT in content delivery thus need for a change in pedagogy and teachers' role.

Globally, studies reveal that instructors' attitude towards new technology is a key determinant of its acceptance and integration in instruction (Keengwe & Onchari, 2008). The Technology Acceptance Model posits that because new technologies such as personal computers are complex and an element of uncertainty exists in the minds of decision makers with respect to the successful adoption of them, people form perceptions and intentions towards trying to learn to use the new technology prior to initiating efforts directed at using these technologies (John, 2015). This means that teachers using new technology would have to consider the perceived usefulness in the use of the new technology to accept it. They would need to believe the new technology to accept it. They would need to belief that using the new technology would enhance their job performance. Furthermore; the teachers would have to consider the perceived ease of use of the new technology. That is, they would have to know the degree to which they believe that using a particular system would be free from efforts. Thus new technology is accepted for use if the teachers perceive that there are personal gains to be obtained.

Albirini (2006) found that teachers have positive attitudes towards ICT in education. For instance, majority of the participants regarded computers as a strong educational tool that can bring about significant improvements to schools and classrooms. Andoh (2012) in Ghana indicated that teachers who believed ICT to be useful in engaging the learner in learning process and acquiring teaching resources from internet used ICT more in content delivery. A study by Alma (2014) on assessing the extent to which Physics teachers in Nairobi County utilize ICT in instruction found out that, the teachers in Nairobi County believed ICT to be beneficial to them and to the learner. In similar vein Makanda (2015) in Bugoma found that Physics teachers recognized the benefits accruing from utilizing ICT, however the instructors were using ICT for general purposes. According to Makanda, this could be attributed to inadequate skills and insufficient time to plan for ICT integrated lessons. These studies did not focus on Chemistry teachers in particular therefore this study attempted to determine the perceptions of Chemistry teachers towards CAL.

METHODOLOGY

The study used quasi-experimental design, to relate to the objective of the study which was to determine the effect of CAL on learners' performance in Structure and Bonding. In this study the sample was categorized into two groups namely experimental and control groups. The experimental group was tested before and after receiving treatment (CAL) while the control group using conventional methods was tested before and after

receiving no treatment. Quasi-experimental design was considered for the present study because the researcher worked with the existing intact classes to guarantee negligible external interference with their learning programs.

The research was conducted in Makueni County and Mbooni East Sub-County in particular. Makueni County is in the former Eastern Province of Kenya. Geographically, it borders Kajiando County to the West, Taita Taveta County to the South, Kitui County to the East and Machakos County to the North. Mbooni East Sub-County had posted low Chemistry grades in KCSE from 2013 to 2017.

All public secondary schools in Mbooni East Sub-County with ICT facilities were targeted for this study. The target population for this study included Form 2 students and their Chemistry teachers. Mbooni East Sub-County has 8 schools with ICT infrastructure that can support CAL based instruction. The study therefore targeted 909 learners and 20 teachers. Form 2 learners were considered for this study since the topic Structure and Bonding is offered at that level.

Public secondary schools in Mbooni East Sub-County with well-equipped computer laboratories were purposively sampled. Students from County schools only were selected since learners in these schools were of comparable abilities. Stratified random sampling was employed to select boys' and girls' County schools based on their school mean grade. Since the study employed quasi-experimental design, the researcher worked with intact groups, therefore, for the form 2 student population, a sample size of 180 was used. The four Chemistry teachers, who administered the treatment, were involved in this study. Thus, the total study sample was 184.

A number of instruments were used in this study. These included: pre-test chemistry achievement test (prcat), post-test chemistry achievement test (pocat), learners' motivational scale and teachers' interview schedule

Pre-test instrument was administered to both experimental and control groups in the third week of January 2020. The students were pre-tested on several topics offered in Form 1 and the first 2 topics offered in Form 2 namely Structure of The Atom and Periodic Table, and Chemical Families. The pre-test was followed by 3 weeks intervention of the CAL for experimental group and CM for control group. The experimental group was taught using e-content material developed by Computers for Schools Kenya (CFCK). At the end of the three weeks intervention, the post-test was administered to both groups to assess the impact of the treatment on learners' achievement levels in Structure and Bonding. Further, students' motivational scale was administered to assess perceptions of learners towards CAL. Post-test and students' motivational scale were administered on the same day. Finally, the researcher interviewed the teachers to obtain information on teachers' perceptions towards CAL.

Quantitative data was analyzed using both descriptive and inferential statistics in the form of means and t-test. The study had four objectives, two based on research hypotheses and the remaining two on research questions. All the hypotheses were tested at 0.05 significance level. The first objective sought to determine the difference in achievement in Structure and Bonding between learners introduced to CAL and those using CM. Data obtained for this objective was analyzed using means and independent t-test.

RESULTS

CAL and Learners' Achievement in Structure and Bonding

The first objective of the study sought to establish whether there was a significant difference in examination performance in the area of Structure and Bonding, between learners introduced to CAL and those taught using CM. First, the researcher presents the pre-test findings followed by the post-test findings. In order to bring a clear descriptive understanding of the differences, the researcher clustered the examination performance based on KNEC grading criteria followed by mean-based comparisons. Table 1 shows the clustered descriptive pre-test results.

Table 1: Pre-test Examination Results

	Test group composition					
	Experimental		**Control**		**Total**	
	F	**%**	**F**	**%**	**F**	**%**
Below 40	53	30.8	51	29.7	104	60.5
40-60	27	15.7	30	17.4	57	33.1
Above 60	6	3.5	5	2.9	11	6.4
Total	86	50	86	50	172	100
Mean	36.78		37.27		37.03	
SD	6.74		5.67		6.21	

The findings show that those who were to be taught using conventional methods performed slightly higher (m=37.27, SD=5.67) than those who were selected for CAL (m=36.78, SD=6.74). In both groups, the standard deviations were quite low, an indication that there was low variations in performance among the students themselves. The low variations can also be explained by the fact that majority of the students who participated in the study scored low marks in pre-test examination. Particularly more than half of the learners (60.5 %) scored below 40% of which 29.7% were from the control group and 30.8% from the experimental group indicating that more of the experimental participants scored low marks in the pre-test. Those who scored between 40-60%, more (17.4%) were from the control group compared to those from experimental group (15.7%). However with regard to those who scored above 60%, more (3.5%) were from experimental group compared to 2.9% from Control group. In general more control participant 20.3% scored above 40% compared to experimental participants at 19.2%. To establish whether the observed mean difference was statistically significant, an independent t-test was used at 0.05 significance level. Table 2 displays the results.

Table 2: Independent t-test for Equality of Means in Pre-test Examination Results

Group	**N**	**Mean**	**SD**	**Df**	**t-value**	**p-value**
Experimental	86	36.78	6.743	170	.514	.608
Control	86	37.27	5.668			

The analysis shows that the observed mean difference, m=36.27 for experimental group and m=37.27 for control group in pre-test performance was not statistically significant, $t(170)=0.514$, $p=0.608>0.05$ which is an indication that both control and experimental groups were almost of equal ability in Chemistry, which is a useful requirement for the study design. After three weeks of intervention, the control and the experimental groups were subjected to another standardized test and results were compared again. Table 3 displays the descriptive findings on the test results for both Control and Experimental groups.

Table 3: Post-test Examination Results

	Test group composition					
	Experimental		**Control**		**Total**	
	F	**%**	**F**	**%**	**F**	**%**
Below 40	39	22.7	63	36.6	102	59.3
40-60	29	16.8	23	13.4	42	30.2
Above 60	18	10.5	0	0.0	18	10.5
Total	86	50	86	50	172	100
Mean	55.27		35.35		45.31	
SD	10.31		5.83		8.07	

The findings show that the students introduced to CAL outperformed their counterparts taught using CM. While the learners introduced to CAL performed slightly above average (m=55.27), those exposed to CM performed way below average (m=35.35). The Experimental group further recorded higher disparity in performance among the learners as observed in the high standard deviation (SD=10.31), which is an indication that CAL helped some learners perform very well while other learners in the same group still performed dismally. On the other hand, there was low disparity in performance among learners within the Control group (SD=5.83), which was an indication that most of the learners were at the same level after being taught Structure and Bonding using conventional method of learning.

Specifically, from the observation more than a half (59.3%) of the learners scored below 40% in the post-test, of these 36.6% were the control participants while 22.7% were experimental participants indicating that the control group performed dismally in post-test examination compared to experimental group contrary to pre-test performance. More learners (16.8%) introduced to CAL scored between 40% and 60% compared to their counterparts (13.4%) taught using conventional method. While 10.5% of those introduced to CAL were able to score above 60%, none of those taught using conventional method attained this level (0%) in the same examination. The implication is that majority of learners introduced to CAL were able to move from low scores to average scores and above while those taught using CM recorded marginal shifts.

To establish whether the observed mean difference in post-test Structure and Bonding examination results of control participants and those introduced to CAL was statistically significant, an independent t-test was employed at 0.05 significance level. The findings were displayed in table 4.

Table 4: Independent t-test for Equality of Means in Post-test Examination Results

Group	N	Mean	SD	Df	t-value	p-value
Experimental	86	55.27	10.31	170	5.592	.001
Control	86	35.35	5.83			

The analysis shows that the observed mean difference, m=55.27 for experimental group and m=35.35 for control group in post-test performance was statistically significant, $t(170)=5.592$, $p=0.001<0.05$, indicating that use of CAL strategy in content delivery positively impacts learners achievement. The null hypothesis that "there is no statistically significant difference in the mean scores of learners introduced to CAL and those taught using CM" was therefore, rejected. From the findings, it can clearly be seen that Experimental group (m=55.27) outperformed the Control group (m=35.35). Compared to pre-test results, the Control group appeared to have performed lower in post-test results.

The findings affirm that the introduction of different learning methods was attributed to the widened gap in performance, where Experimental group recorded significant improvement while Control group recorded low examination performance in Structure and Bonding. Studies have attested that utilization of CAL in content delivery leads to significant gain in test scores. These findings are supported by Serin, (2011) in a meta-investigation that was performed to determine the general effect of CAL in teaching Chemistry, Biology, Physics and Computer, the outcomes demonstrated that CAL positively impacts the students achievement where normal learner accomplishment moved from 50 percentile to 87 percentile in learning Science when the CAL was utilized. Similarly Morgil et al. (2005) in a study on impacts of CAL on learners' performance in Acids and Bases showed significant gain in Chemistry test scores in favour of experimental group. On the same note Akcay et al. (2006) reported a significant improvement in Analytical Chemistry performance for students' taught using Computer Based Learning compared to those taught using CM. These findings also agree with that of Frailich et al. (2007) who found that application of ICT such as web-based learning boosts learners' mastery of Chemistry concepts.

However, Kozma and Russel (2010) asserted that Chemistry consists of abstract concepts that are not easy to comprehend. This is due to the fact that the learner must have a mental picture of the basic concepts in order to

comprehend the phenomena. In addition Ogeng'o (2012) postulates that Chemistry is perceived to be difficult by learners due to its abstract nature. Chemistry and particularly Structure and Bonding deals with materials and concepts that are quite abstract than real, hence integration of ICT in teaching does concretize the concepts enhancing learners understanding. In addition, ICTs such as CAL are powerful instructional materials if integrated with interactive approaches as they motivate and engage learners in the learning process and make the abstract concept concrete for easier understanding (Haddad, 2002).

On the whole, it was noted from the finding that use of CAL in Chemistry instruction (structure and bonding) is a better instructional strategy which impacts positively in learners' performance. This observation agrees with that of Nyaga (2011) who revealed that learners taught through Computer Assisted Instruction attained significantly higher scores in Science than those exposed to conventional instructional techniques. This is consistent with the findings of Nduati (2015) who agrees that integration of CAL positively impacts learners' academic achievement.

Gender Effect on Achievement of Learners Introduced to CAL

The second objective of the study sought to establish the gender effect on Structure and Bonding examination achievement of learners introduced to CAL. First, the researcher analysed the pre-test performance followed by the post-test, in order to establish whether exposure to Computer Assisted Learning led to significant differences in performance between boys and girls. Further, the researcher put the performance in categories based on KNEC grading in order to bring a better understanding of the observed differences in both pre-test and post-test results. Table 5 below displays the descriptive findings of the pre-test Structure and Bonding examination performance.

Table 5: Pre-test Examination Results for CAL Group

	Test group composition					
	Boys		Girls		Total	
	F	%	F	%	F	%
Below 40	24	27.9	29	33.7	53	61.6
40- 60	15	17.4	12	14.0	27	31.4
Above 60	4	4.7	2	2.3	6	7.0
Total	43	50	43	50	86	100
Mean	36.95		36.61		36.78	
SD	6.54		7.01		6.78	

From the findings in the above table, boys performed slightly better than girls with the latter recording a mean of 36.61 while the former recorded a mean of 36.95. The findings further show that the disparity in performance among students themselves was quite low for both boys (SD=6.54) and girls (SD=7.01), though girls appeared to record higher disparities.

Specifically, more than half (61.6%) of the students performed below 40%, with more girls (33.7%) than boys (27.9%) falling in this category. On the flipside, more boys (17.4%) than girls (14.4%) recorded better performance in the category of between 40% - 60%. Similar observation was made in the category of above 60% with more boys (4.4%) compared to girls (2.3%). In general, there was evidence showing that boys recorded better performance in Structure and Bonding. The researcher therefore, sought to establish whether the observed mean differences were statistically significant. An independent t-test was carried out at 0.05 significance level. Table 6 displays the findings.

Table 6: Independent t-test for equality of means in pre-test examination results by gender

Group	N	Mean	SD	Df	t-value	p-value
Boys	43	36.95	6.54	84	.232	.817
Girls	43	36.61	7.01			

The observed mean differences in performance between boys (m=36.95) and girls (m=36.61) was not statistically significant t(84)=0.232, p=0.817>0.05, which is an indication that both boys and girls were almost of equal ability in Chemistry.

A post-test analysis was also performed in order to establish whether different interventions employed led to significantly different examination performance between boys and girls. Table 7 displays the descriptive findings based on similar categories of performance used in pre-test analysis.

Table 7: Post-test examination results for CAL group

	Test group composition					
	Boys		Girls		Total	
	F	%	F	%	F	%
Below 40	20	23.3	19	22.1	39	45.4
40-60	12	13.9	17	19.8	29	33.7
Above 60	11	12.8	7	8.1	18	20.9
Total	43	50	43	50	86	100
Mean	55.67		54.89		55.28	
SD	10.86		9.86		10.36	

From the findings, there was a slight difference in mean performance between boys and girls, with boys (m=55.67) edging the girls (m=54.89), an indication that there was no much departure from the pre-test findings. Furthermore, the disparity in performance among the learners themselves was high for both boys and girls though boys posted higher variations (SD=10.86) than their girl counterparts (SD=9.86). Particularly slightly below half (45.4%) of the learners scored below 40%, of these more (23.3%) were boys compared to girls (22.1%). On the category of between 40% and 60%, more girls (19.8%) were represented than boys (13.9%). However, when it comes to higher performance category of above 60%, the boys (12.8%) outperformed girls (8.1%), an indication that just like in pre-test results, girls' slightly trailed boys.

To establish whether the observed mean differences were statistically significant, an independent t-test was performed at 0.05 significance level. The findings were as displayed in table 8 below.

Table 8: Independent t-test for Equality of Means in Post-test Examination by Gender

Group	N	Mean	SD	Df	t-value	p-value
Boys	43	55.67	10.86	84	.349	.728
Girls	43	54.89	9.86			

From table 8 it was evident that the observed mean difference in performance between boys (m=55.67) and girls (m=54.89) was not statistically significant t(84)=0.349, p=0.728>0.05, which is an indication that boys and girls equally gain from CAL hence gender did not have a significant effect on learners' performance in Structure and Bonding examination. Therefore, gender was not really an important determiner of the impact of CAL on learners' performance in Chemistry (Structure and Bonding) examination. The null hypothesis that 'There is no statistically significant difference in the mean scores of male and female learners introduced CAL' was therefore, accepted. From the findings, it can clearly be seen that Experimental group (m=55.67) outperformed the Control group (m=54.89) consistent with the pre-test results.

The findings are consistent with that of Fatokum et al. (2016) who on effect of simulation games on Chemistry learners' performance in Nigeria reported insignificant difference in retention between the male and female learners exposed to treatment. This is in line with Ezeudo and Ezinwanne (2013) who asserted that use of simulation games in Chemistry instruction impacts learners' performance positively and insignificant difference on gains based on gender. In a similar vein Ezeudu (2014) stated that gender has no influence on student's outcome and retention in Organic Chemistry that is both male and female students showed the same level of achievement and retention. However, it contradicts that of Wanyonyi et al. (2012) in Bungoma West District

who reported that the performance of boys in Chemistry was significantly higher compared to the performance of girls (F = 9.912; p = 0.002), indicating gender gap in understanding of these concepts. Similar observation was made by Muchiri (2018) in Tharaka Nithi County, who reported a significant improvement in the mean scores based on gender in favour of male students after exposure to computer assisted technique strategy.

Generally the findings showed insignificant effect of use of CAL on learners achievement based on gender, an indication that use of CAL impacts performance of boys and girls equally. This is supported by Nussbaum (2000) who found insignificant difference between male and female performance. Similarly Dahiru (2004) reported that there was no significant difference between gender and selection of science subject. It is consisted with that of Ogembo (2017) who on effects of CAL on Chemistry instruction in Kwale County showed no significant difference in mean scores between the boys and girls after exposure to CAL.

Perceptions of Learners Towards CAL

The third objective of the study sought to determine the perceptions of learners towards CAL. Learners' motivational scale consisting of 10 items on a 5-point Likert scale of strongly disagree, disagree, not sure, agree and strongly agree was used to collect information on learners' perceptions towards CAL. The students were asked to indicate the extent to which they agreed with the statements. Data obtained was coded and analysed using coding method. Table 9 shows the results.

Note: 1=Strongly Disagree, 2= Disagree, 3=Not sure, 4=Agree, 5=Strongly Agree.
*****Negative statements were reverse coded*

Table 9: Student's Perception Towards CAL

Statement	**1**		**2**		**3**		**4**		**5**		Mean
	F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	(Max=5)
Use of CAL makes learning of Chemistry more enjoyable	7	4.1	12	7.0	38	22.1	32	18.6	83	48.3	4.00
Use of CAL makes me understand Chemistry concepts better	14	8.1	32	18.6	43	25.0	52	30.2	31	18.0	3.31
Use of computer reduces time taken to understand difficult concepts	7	4.1	42	24.4	45	26.2	59	34.3	19	11.0	3.24
Technology makes learning of Chemistry more effective	20	11.6	44	25.6	44	25.6	37	21.5	27	15.7	3.04
Use of CAL in learning Chemistry is time consuming	40	23.3	56	32.6	33	19.2	31	18.0	12	7.0	2.53
Use of CAL offers a wide range of experience that are otherwise not available	6	3.5	7	4.1	44	25.6	70	40.7	45	26.2	3.82
Computer is a valuable device for learning Chemistry	33	19.2	30	17.4	27	15.7	55	32.0	27	15.7	3.07
I can still learn Chemistry better without the computer	13	7.6	13	7.6	12	8.1	81	47.1	51	29.7	3.80
Computer is not conducive for learning	51	29.7	44	25.6	30	17.4	20	11.6	27	15.7	2.58
Computer is suitable for use in entertainment	102	59.3	7	4.1	20	11.6	20	14.5	18	10.5	2.01
Overall mean											**3.14**

From table 9 mean rating for all positive statements were in the range 3<x>5 while those for negative statements except one were in the range 1<x>3. In addition, respondents scored high for perception (3.14 out of 5) indicating that generally majority of learners had a positive perception towards Computer Assisted Learning. Specifically, about a third (66.9%) of the students indicated that use of CAL makes learning of Chemistry more enjoyable and use of CAL offers a wide range of experience that are otherwise not available as attested by the highest mean rating (M=4.00) and (M=3.82) respectively. These findings are supported by Slouti and Barton (2007) who argued that application of ICT such as CAL in instruction captures the learners' attention and enhances their interest in classroom. A similar proportion (63.4%) refuted that Computer is suitable for use in entertainment and use of CAL in learning Chemistry is time consuming (55.9%) as well as computer is not conducive for learning (55.3%). The findings suggest that majority of students consider computers as important tools for learning, though it is apparent that some are skeptical about its role in promoting their achievement in Chemistry, as Elaheh et al. (2014) showed a significant improvement in achievement for learners' exposed to Computer Assisted instruction implying that a positive attitude is critical to the effectiveness of CAL.

Similarly, slightly less than a half (47.7%) acknowledged that Computer is a valuable device for learning Chemistry and use of CAL makes me understand Chemistry concepts better (48.2%) as well as use of computer reduces the time taken to understand difficult concepts (45.3%). The findings imply that despite the students being exposed to computers, some of the students may not be conversant with how to use computers for learning hence the perceived benefits of computer aided learning in reducing time spent in learning concepts may not be maximized. As a result, the students and teachers may miss out on the benefits of CAL as, Morgil et al. (2005) in a study on Acids and Bases revealed a significant gain in Chemistry test scores in favor of experimental group. On the same note Myers and Halpin (2002) asserts that positive attitude of learners towards integration of ICT in instruction will lead to its frequent use in the future resulting to positive impact on students' performance.

The findings on these statements among others could be interpreted to imply that a significant proportion of the students have a positive perception towards CAL thus the relatively higher mean rating of the statements with 6 out of 10 statements receiving a mean rating of more than 3 out of 5. However, the fact that, more than three quarters (76.8%) of the respondents affirmed that they can still learn Chemistry better without the computer with only 15.2% claiming that they cannot perform better in Chemistry without use of computers shows that there is equally negative perceptions towards CAL among the learners. These findings suggest that despite some students perceiving computers as valuable devices for learning Chemistry, majority believe they can learn Chemistry better even when there are no computers.

Generally, the results from the table shows that, perceptions of students on the use of computers and CAL strategy are positive, but not all of the students perceive the CAL and computers as being crucial in their Chemistry performance. This is in line with Selwyn (1999) who reported that the limited use of ICT in teaching and learning is attributed to the negative attitude of learners and teachers towards ICT. Similarly, Ikwuka (2010) argues that ICT integration leads to increased understanding motivates learners and facilitates critical thinking. On the same note Akcay et al. (2003) showed that the performance of learners taught through simulations was better compared to that of control group. Akcay added that integration of CAL in teaching and learning could be an effective method of enhancing students' motivation towards Chemistry. Therefore, the effectiveness of ICT integration such as CAL in instruction can be predicted by learners' perceptions towards its use hence if learners perceive ICT use to be useful they will be more motivated in their learning.

The study also purposed to determine whether the learner's perceptions of CAL use was influenced by instructional method used. Chi-square goodness of fit test was conducted at 0.05 significance level to determine the likelihood of the instructional method influencing the perceptions of students towards CAL. The table 10 shows the results.

Table 10: Chi-Square Results- Instructional Methods and Student's Perceptions of CAL

Statement	N=172	CM		CAL		P Value
		F	%	F	%	
Use of CAL makes learning of chemistry more enjoyable	Yes	56	32.6	60	34.9	0.016
	No	30	17.4	26	15.1	
Use of CAL makes me understand Chemistry concepts better	Yes	18	10.5	60	34.9	0.036
	No	65	37.8	29	16.9	
Use of computer reduces the time taken to understand difficult concepts	Yes	37	21.5	46	26.7	0.026
	No	46	26.7	43	25.0	
Technology makes learning of Chemistry more effective	Yes	26	15.1	50	29.1	0.031
	No	57	33.1	39	22.7	
Use of CAL in learning Chemistry is time consuming	Yes	70	40.7	19	11.1	0.016
	No	24	13.9	59	34.3	
use of CAL offers a wide range of experience that are otherwise not available	Yes	31	18.0	58	33.7	0.015
	No	55	33.7	28	16.3	
Computer is a valuable device for learning Chemistry	Yes	42	24.4	47	27.3	0.046
	No	42	24.4	41	23.8	
I can still learn Chemistry better without the computer	Yes	61	35.5	22	12.8	0.029
	No	19	11.1	70	40.7	
Computer is not conducive for learning	Yes	26	15.1	24	13.9	0.032
	No	57	33.1	65	37.8	
Computer is suitable for use in entertainment	Yes	23	13.4	21	12.2	0.001
	No	62	36.0	66	38.4	

Data obtained showed that from 67.5% of students who claimed that the use of CAL makes learning of Chemistry more enjoyable, more (34.9%) were those instructed using CAL compared to 32.6% taught using CM. Additionally a similar proportion of the respondent (34.9%) from CAL group agreed that CAL makes them understand Chemistry concepts better compared to 10.5% from CM group. Similarly more of respondents in CAL group maintained that CAL offers a wide range of experience that are otherwise unavailable (33.7%) compared to 18.0% in CM group, that computer is a valuable learning devices (27.3%) compared to 24.4% in CM group, that use of computer reduces the time taken to understand difficult concepts (26.7%) compared to 21.5% in CM group and that technology makes learning of Chemistry more effective (29.1%) compared to 15.1% in CM group.

Similarly about half (51.8%) of students refuted that they can learn Chemistry better without computers, more (40.7%) being those taught using CAL compared to 11.1% taught using CM. Further 34.3% of respondents in CAL compared to 13.9% in CM group refuted that use of CAL in learning Chemistry is time consuming. Additionally, majority (70.9%) of students refuted that computers are not conducive for learning Chemistry, more (37.8%) being those from CAL compared to 33.1% from CM group. Almost three quarters (74.4%) of the respondents refuted that computer are suitable for entertainment, of which more (38.4%) were those instructed using CAL compared to 36.0% taught using CM. The findings show that exposure to CAL instructional method changes the perceptions of students towards use of CAL in Chemistry instruction. This is also evident in the statistically significant p-value range of $0.000<x<0.05$. The findings are consistent with that of Halakova (2009) who asserted that the motivation of students towards utilization of ICT such as CAL in learning greatly depends on its perceived usefulness. Similarly, Ogembo (2017) found that CAL positively impact learners' attitude when used in teaching of Chemistry.

Generally, from the table 10 and the discussions above, it is evident that the exposure of students to CAL influences their perceptions of CAL as a tool of teaching and learning Chemistry. All of the items in the Likert

scale were statistically significant (x>0.05) which shows that the instructional method has a significant influence of how students perceive the use of CAL as a tool for learning and teaching Chemistry. These findings suggest that when students are exposed to CAL and computers, they get to experience the benefits of the CAL as instructional method over the conventional methods however, for the student's instructed using conventional methods, the perceived benefits of the CAL and computers are missed; hence their perceptions of the benefits of CAL and its effectiveness as a teaching and learning method for Chemistry is negative.

Perceptions of Teachers of Chemistry Towards CAL

The fourth objective of the study set out to determine the perceptions of teachers of Chemistry towards Computer Assisted Learning. To meet this objective, the researcher interviewed the four teachers in the respective schools selected as control and experimental centers. All of the four teachers were successfully interviewed and their opinions solicited.

Table 11: Teacher's Codes

Code	School
A	Experimental
B	Experimental
C	Control
D	Control

First, it was evident that the performance of students in Chemistry in the selected schools was quite poor as all of the teachers sampled in the study stated that the performance of their schools was low (mean score of below C). From these assertions, it is evident that the performance of students in Chemistry is quite low a fact supported by the descriptive statistics in table 11 where a mean of less than 50 was found for the performance of students in the subject. The respondents were further asked, what could be done to improve the performance of students in the subject. According to teacher **A**;

"Motivating and encouraging the students to change their attitudes towards the subject promote improved performance; therefore, there is a need for the teachers to change the teaching methods."

Teacher **B** had a similar view claiming that the learners had to first and foremost be encouraged to change their attitudes towards the subject. He asserted that the students join Form 1 and immediately perceive Chemistry as a difficult subject, and most do not work towards changing this perception. Therefore, if there is to be a change in the mean performance in Chemistry, the student's attitude should first be dealt with.

The teachers were also asked to state the possible causes of the low performance in their schools. Teacher **C** argued that the main reason was low entry grades by the students. The teacher opined that majority of the students admitted to the school had low grades, and as such, the performance of these students remained even low after joining secondary school. The low entry grades according to teacher **C**, contributed to the continued poor performance among the students whose low levels of confidence and self-esteem leads to deterioration of their performance.

Attitude was the other reason cited by the respondents according to teacher D;

"Majority of students have a negative attitude towards Chemistry which puts them off from focusing during lessons as well as lack of motivation towards revising sufficiently for Chemistry examination. This may be attributed to the 'perceived' difficulty of the subject by majority of students who belief that Chemistry is a difficult subject. The other reason is the lack of proper revision techniques and resources."

All of the respondents also claimed that the schools lacked sufficient revision textbooks and other resources to facilitate improved student performance in Chemistry. As a result, majority of students are forced to share revision textbooks and when coupled with the lack of well-equipped laboratories, this problem compounded leading to poor performance in Chemistry which, in its nature, is a practical subject. In fact, teacher **C** claimed

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that majority of students have to conduct experiments in groups during class practical sessions yet when it comes to the exams, they have each to do it alone which has also contributed to the low scores in the practical examination. This is because some of the students do not get an opportunity to experiment personally what the teachers teach during the practical lesson.

The teachers were then asked, whether the use of computer assisted learning in instruction can improve performance in Chemistry. The table 12 displays their responses.

Table 12: CAL and Improvement of Performance

Response	F	%
Yes	3	75
No	1	25
Total	4	100

The table 12 shows that, majority of the respondents 3(75%) stated that the use of CAL influences the performance of learners in Chemistry positively. However, one of the respondents claimed that it somehow influences the achievement of students in Chemistry. This shows that not all of the teachers believe that the adoption of CAL over conventional methods result in improved student achievement in Chemistry. This may be due to the limited ICT resources as well as the lack of well-trained teachers who are competent in the use of ICT in teaching and learning Chemistry. The limited resources in terms of computers are also a constraint that hinders the effective use of CAL to facilitate improved performance.

The researcher then asked the respondents to explain how computer assisted learning influences the student's achievement. Respondent **C** identified one way as the simplification of abstract content through animation and video clips. The respondents also claimed that;

Computers arouse the student's interest in the subject. It makes the subject entertaining especially when visuals like cartoons are used to simplify the content. As a result, the student's attention is captured on what the teacher is instructing. They are also highly engaged in the teaching sessions which improve their comprehension of the content taught.

Similar views were expressed by respondent **B** who opined that the use of clips and animation is the best way of simplifying the complex abstract concepts in Chemistry. The young generation relate well with animations and short-clips rather than having to spend hours reading abstract concepts. The appealing nature of clips and animations make the subject concepts easy to understand and remember.

Respondent A and D claimed that CAL makes content delivery easy and simple for the students. As such, students can easily visualize and understand what would otherwise be abstract contents. Due to the potential of the CAL instructional method to improve student performance, the teachers claimed that between CAL and conventional instructional methods, CAL is their preferred instructional approach. These findings are supported by Ogeng'o (2012) who asserts that Chemistry is perceived to be difficult by learners due to its abstract nature. This is due to the fact that the learner must have a mental picture of the basic concepts in order to comprehend the phenomena. Chemistry and particularly Structure and Bonding deals with materials and concepts that are more abstract than real, hence integration of ICT in teaching can concretize the concepts enhancing learners understanding. Haddad (2002) asserted that ICTs are powerful instructional materials if integrated with interactive approaches as they motivate and engage learners in the learning process and make the abstract concept concrete for easier understanding.

Lastly, the teachers were asked to give a reason as to why they would prefer to use CAL over the conventional methods. All the teachers claimed that the use of CAL improves efficiency during instruction. This is due to the ability of CAL to simplify abstract concepts. Additionally, the teachers also claimed that it promotes learner

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creativity by arousing interest in learning new concepts which promotes their understanding of new concepts in the subject.

Teacher **D** also claimed;

"The use of CAL makes the learners active and less bored as compared to the other methods of teachings including lecture methods."

This is supported by teacher **A** who claims that the use of ICT and computers to teach Chemistry makes the lesson more enjoyable and interactive for the learners. Teacher **B** also opined that by engaging the students, CAL offers a new way of learning which simplifies abstract concepts leading to a change in the student's attitudes towards the subject. These sentiments are supported Gonzalez and Birch (2000) that CAL has the potential to make learning more effective. In addition CAL through simulations enhances the comprehension of abstract concepts and also provides three dimensional pictures that motivate the learners and satisfy their curiosity about scientific concepts (Agrahari and Siggh, 2013). This is supported by Mintz (1993) who argued that CAL through simulations can concretize the abstract science related concepts including Structure and Bonding.

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CONCLUSION AND RECOMMENDATIONS

From the results discussed in the preceding sections, this study draws four main conclusions. Firstly, in purposing to determine the effect of CAL strategy on learners' achievement in Chemistry (Structure and Bonding), the study findings evidently show that the mean difference between learners introduced to CAL and those taught using CM were statistically significant. Specifically, the mean achievement of learners exposed to CAL was significantly higher than the mean achievement of those taught using CM. This shows that the use of CAL positively impacts the performance of students in Chemistry therefore, CAL is a better instructional strategy compared to conventional methods.

Secondly, in seeking to establish the gender effect on the achievement of learners introduced to CAL, the post-test results showed that the mean difference between boys and girls taught Structure and Bonding using CAL were statistically insignificant. Generally, gender had no significant effect on the achievement of learners introduced to CAL. Therefore, the study concluded that CAL improves students' achievement in Chemistry across gender thus it benefits both boys and girls equally.

Thirdly, in seeking to determine the perceptions of learners towards CAL, the findings revealed that, students perceive CAL positively. This shows that students think that CAL has a positive influence on their performance in Chemistry. Therefore, the study concluded that students perceive CAL as an effective instructional method that simplifies and enables visualization of abstract concepts in Chemistry. This cannot only help teachers to teach in a meaningful way (for understanding) but also cover the syllabus in good time.

Lastly, the study had sought to determine the perceptions of teachers of Chemistry towards CAL. The findings showed that teachers perceive CAL as a good alternative to conventional methods of instruction. The study therefore, concluded that teachers perceive CAL as an important instructional method to promote improved performance amongst the students.

The study made the following recommendations for action.

- The study established that use of CAL as an instructional strategy impacts learners' performance positively, therefore intensive application of computer assisted learning in content delivery is recommended to promote student's understanding of abstract concepts in Chemistry.
- The study also found that CAL improves learners' achievement across gender, both boys and girls should be encouraged to embrace computer and ICT integration in learning Chemistry to promote ease and simplicity in understanding concepts.

- Since the study established that Students perceive CAL as an effective instructional method that simplifies and enables visualization of abstract concepts in Chemistry, learners should be exposed to computer use as a source of learning rather than a source of entertainment to promote their adoption and acceptance of CAL as a superior learning method.
- The study also established that teachers perceive CAL strategy to be a better teaching method compared to CM, schools should equip their computer laboratories with sufficient resources to promote the adoption of CAL. Principals should also facilitate in-service training for teachers on integration of ICT such as CAL in teaching and learning Chemistry.

Recommendations for Further Studies

The study recommends that future related studies should focus on;

- Effect of CAL on Chemistry students' performance in private secondary schools in Makueni County since this study was delimited to public secondary schools only.
- Comparative study of the effect of CAL on the teaching and learning of Chemistry in rural and urban based counties in Kenya.
- How the student's experience and competency in using ICTs impacts their perceptions on the effectiveness of CAL.

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