Effect of Computer Assisted Instruction on Pre-Service Teachers' Conceptual Change of Chemistry Concepts at St. Ambrose College of Education in Bono Region, Ghana

[1]James Osei Kwabena, [2]Vitus Samlafo, [3]Eric Appiah-Twumasi, [4]Mark Kwasi Acheampong
[1, 3] Science Department, Berekum College of Education, Ghana
[2] Department of Chemistry Education, University of Education, Winneba, Ghana
[4] Science Department, St. Ambrose College of Education, Ghana

*Corresponding author: jimmykobby2002@yahoo.com

Abstract: The study examined the effect of computer-assisted instruction (CAI) on pre-service teachers' performance in reaction rate concepts. The research employed the quasi-experimental design of a one group pretest-posttest type. A sample of one hundred and fifty (150) pre-service teachers were selected from an accessible population of level hundred (L100) students from the St. Ambrose College of Education at Dormaa Akwamu in the Bono Region of Ghana. Reaction Rate Concept Test (RRCT) was used to gather data for the research. Percentages and Means were used to answer research questions. The results show that the CAI strategy has a positive effect on pre-service teachers' performance on reaction rate concepts. The study again shows that the use of CAI can improve learners' performance in science and can help learners in high-level cognitive performance. CAI strategy proved to be an effective conceptual change teaching strategy in science. Based on the results obtained, it is recommended that science teachers should adopt the CAI and other ICT related strategies in teaching for improved learning outcomes in Chemistry.

Keywords: Conceptual change, Misconception, Computer-assisted instruction, simulation, Chemistry, science teaching

Introduction

Students have always faced challenges and difficulties when it comes to the acquisition of abstract concepts (Johnstone, 1993). Indeed, various researches in science education have accepted this fact. Verkade, et al. (2017) assert that if students' preconceived beliefs are accurate, they will not hinder further understanding but when the preconceived ideas conflict with the scientifically accepted concepts, the situation can lead to a systematic pattern of error.

Knowledge in chemistry is generated and communicated at three different levels; the macro, the submicro and the symbolic (Ngozi and Norman, 2006; Talanquer, 2011). While students have an easier task in grasping ideas at the macro level, the micro is so abstract that it can only be perceived with the aid of instruments. The challenge stems from students' inability to perceive the particulate concepts and to relate the concept to daily occurrences and observations. Hence concept acquisition at the micro-level pose a challenge to students (Talanquer, 2011). Nadelson, et al (2018) admit that conceptual change can be a challenging process, especially, in science education where complex concepts are dealt with particularly in science education where many of the concepts are complex, controversial, or counter-intuitive. Indeed as in any learning situations, students hold a lot of varied conceptions in chemistry-related topics that might need to change. The preconceptions of students which develop in their daily interaction with the environment may be far from the scientifically accepted ideas and concepts. Therefore, teachers are responsible to know these preconceptions and teach in ways that will facilitate

conceptual change on the part of the learner (Nadelson, et al., 2018).

From the constructivist viewpoint, learners should be given a chance to construct their own meaning in their own ways rather than being given meanings. But in doing so, learners' already existing ideas need to be dealt with.

In previous research, Pine, Messer and John (2001) concluded that children have many misconceptions about science topics and these misconceptions are of considerable importance and cannot be ignored in the learning process. This is why teachers need to place as much emphasis on children's incorrect ideas as on their correct ones if they want to accomplish conceptual change in science. Science instructions should involve students in hands-on' and 'minds-on' activities to make it easier for students' conceptual change. This suggests the use of laboratory activities which could present students with the opportunity to construct their meaning. While the provision of materials and equipment for laboratory activities is capital intensive, many developing countries can hardly provide the needed resources for implementing a practical –based science curricula. Such countries turned to give special attention to selected schools at the neglect of the rest. Hence the overall quality of science teaching in colleges suffers (Nagao, Rogan & Magno, 2007; Adu-Gyamfi, 2014; Yeboah, Abonyi & Luguterah, 2019). In the absence of hands-on laboratory activities, students resort to memorizing concepts for the sake of examinations. This has led to their poor performance on concepts such as reaction rate.

When questions are asked to develop conceptual understanding, students' thoughts, ideas and experiences can be revealed. According to Bloom's taxonomy, learning behaviours are classified into six levels (Amer, 2006): knowledge, comprehension, application, analysis, synthesis and evaluation. At the knowledge level, pupils are able to recall the previously learned material; knowledge represents the lowest level of learning outcomes in the cognitive domains. Comprehension involves grasping the meaning of the material. Application refers to the ability to use learned material in new and concrete situations. This may include the application of rules, methods, concepts, principles, laws, theories, etc. Analysis involves the ability to break down material into its component parts so that its organisational structure may be understood.

This may include the identification of parts, analysis of the relationships between parts and recognition of the organisational principles involved. Synthesis is the learner's ability to put parts together to form a new whole. Evaluation refers to the ability to judge the value of the material. Application, analysis, synthesis and evaluation are considered to be at the higher levels than Knowledge and understanding. According to Efe and Efe (2011), there is the need for questions probing higher levels of the cognitive domain.

Several studies have touted the effectiveness of computer assisted instruction (CAI) as a conceptual change teaching strategy. According to Nazimuddin (2015), computer assisted instruction is the use of a computer to provide instruction, the format of which can be from a simple typing to a complex system that uses the latest technology to teach surgery technics. The literature reveals that the use of computer-assisted instruction (CAI) in the teaching and learning processes has a positive influence on the achievement of students in all science subjects (Saminathan, 2012; Aladejana 2013 and Furo, 2015). This is made possible because of the added advantage of the visual effect coupled with the interactive nature of the instruction. Computer-assisted instruction (CAI) therefore adds action to information and helps students to see the unseen symbolic representation forms, to test the theoretical concepts and understand abstract ideas (Ozmen, 2008). When integrated into instructions CAI results in positive effects on the learners. For instance, Ozdemir and Oner (2015) observed that Computer Simulations make instructions more attractive to learners and hence sustains their attention. The simulations are also effective in student motivation to engage in learning which ensures their effective participation. Indeed, instruction without motivation might not lead to the desired objective.

According to Saini (2014), there is a need to increase the integration of technology into the delivery of education to make learning become more learner cantered. For Saini, CAI has become important because the activities of a computer make the learning process systematic and the learners learn according to a pre-set system. CAI involves the use of multiple senses; multimedia approach of computer involves all types of hardware designed to make use of all the senses in the learning process. CAI is used in a variety of ways to make the study attractive and as a result, learners take interest in

the learning process. CAI also ensures improved accuracy, individualized learning and provides effective feedback.

In this situation where students' misconceptions have impaired their ability to develop appropriate concepts in science, it becomes imperative to adopt computer-assisted instruction as a conceptual change strategy in learning science. The study was guided by the following two research questions: (1) what is the effect of CAI strategy on conceptual change of pre-service teachers in reaction rate concepts? (1) To what extent can CAI help students in the acquisition of high-level cognitive skills?

Review of Related Literature
In this section, theoretical and empirical literature is reviewed in relation to students' misconceptions in science. Furthermore, the effect of computer assisted instruction as conceptual change instruction in science is reviewed.

Misconceptions related to Rate of Chemical Reactions
It is known that chemistry is one of the most difficult subjects among the sciences across various educational levels in Ghana. Students, therefore, have difficulties understanding basic concepts in learning chemistry (Tirfu & Tilahun, 2016; Treagust, Nieswandt & Duit (2018),

Various studies on students' understanding of concepts in chemistry have revealed that students have many misconceptions. Among the areas of misconceptions are chemical bonding (Abdul & Shilna, 2013), chemical reactions (Ozmen & Ayas, 2003), equilibrium (Bonarjee, 1991), stoichiometry (BouJaoude & Barakat, 2000; Hanson, 2016), atomic structure and molecules (Nakiboglu, Benlikaya & Kalin, 2002), acids and bases (Cetingul & Geban, 2005; Lin & Chiu, 2007) and chemical bonds (Coll and Treagust, 2001; Ozmen, 2008). While these are indications of research on misconceptions in chemistry, there is quite limited research on students' understanding of the rate of reaction concepts using computer-assisted instruction in Ghana.

A study carried out by Chuephangam (2000) in Thailand about students' misconceptions about reaction rates revealed that students had misconceptions in understanding meaning of reaction rates and explanation of factors that affect the rate of reaction. A similar study carried out by Geban (2012) showed that prospective chemistry teachers held misconceptions about the rate of reaction. The participants of the study could not use the collision theory to explain the effect of concentration and temperature on the reaction rate. Geban and Kaya (2012) also reported that students had misconceptions in reaction rate concepts.

Conceptual Change Teaching Strategies
Students' misconceptions of chemistry if not checked can affect the understanding of concepts and achievement in science. According to Cakir (2008), science teaching will be more effective if science teachers understand the barriers to students' conceptual learning and adopt appropriate strategies of dealing with those misconceptions.

Several studies have delved into the effects of several instructional approaches in handling misconceptions of students in science. Such effective strategies include concept maps, conceptual change texts (Sungur, Tekkaya & Gebban, 2001), cooperative learning strategy (Basili & Sanford, 1991), conceptual change oriented instruction through demonstration (Geban & Kaya, 2012). Computer-assisted instruction has also been found to be effective as a conceptual change strategy (Njoku & Phoebe, 2014). All the various teaching strategies identified as effective conceptual change approaches seem to have in mind the ideas of the Conceptual Change Model (CCM) proposed by Posner et, al. (1982). According to the CCM, there are four essential conditions for conceptual change; *dissatisfaction* with one's current conception, followed by the degree to which the new conception is deemed *intelligible*, *plausible* and *fruitful* (Posner et, al. 1982). For a new concept to be assimilated or accommodated, it must be intelligible, plausible and fruitful. These conditions must be met during the learning process as the teacher leads the learners towards creating cognitive conflicts to make the learners dissatisfied with their existing concepts. For Kruise (2010), conceptual change takes effort, time and perseverance but also demands that the approach be seen by teachers as intelligible, plausible and fruitful.

One of the common instructional approaches to bring about a conceptual change among students is to present them with a situation that conflicts with their existing conceptions as students try to resolve the conflict they reflect on their concepts (Posner et

al., 1982). The students then must undergo the process of accepting, using and integrating the new concepts into their lives and even apply them to a new situation.

There are other models of conceptual change such as Cognitive Reconstruction of Knowledge Model (CRKM) by Dole and Sinatra (1998), Gregoire's (2003), Cognitive-Affective Model of Conceptual Change (CAMCC) and Nadelson, et al's (2018) Dynamic Model of Conceptual Change (DMCC). Whereas some models consider conceptual change from only socio-cultural context, Ozdemir and Clark (2007) explained that the conceptual change theory proposed by Posner et al (1982) sees conceptual change as more than just a sociocultural interaction or a teaching strategy but as a process of identifying prior misconceptions which the learners carry into the environment in order to help the learner exchange the misconceptions or add new conceptions that are more useful, plausible and intelligible.

Effects of CAI on Student Achievement

Studies on simulations in the classroom have reported positive findings about students' achievement in the various science subjects, overall. Literature indicates that simulations can be effective in developing content knowledge and process skills as well as in promoting more complicated goals such as inquiry and conceptual change (Smetana & Bell, 2012). In support of Bell and Smetana, Aina (2013), stated that the use of CAI has resulted in gains in student understanding and achievement in general science process skills and across specific subject areas including physics, chemistry, biology, earth and space science. Indeed, the enhanced achievement of science students after their exposure to CAI is reported by literature (Adedamola, 2018; Tolbert, 2015).

In contrast Owusu, Monney, Appiah and Wilmot (2010) carried out quasi-experimental research using 75 second year SHS students from two randomly selected schools in Cape Coast. Using pretest, posttest and semi-structured interview, the results showed that the use of CAI is not superior to the conventional approach. Owusu, et al., (2010) however, revealed that when CAI is used to teach students the achievement of the low achievers in the group is enhanced and thus at the end of the day both the low and high achievers will perform better.

Erdemir (2011) determined the effect of PowerPoint on students' achievement in physics over traditional lectures, using pretest-posttest control group quasi-experimental research design on 90 pre-service science teachers in physics education in a university in Turkey. The t-test analysis of the data indicated that the PowerPoint Presentations' (PPPs) group had higher grades than the control group. Erdemir, therefore, concluded that the effective use of PowerPoint is capable of increasing students' achievement. Similarly, Susskind (2007) determined the limits of 'power point's power' in enhancing students' self-efficacy and attitude. In a quasi-experimental study with two groups design, 80 students participated in the research. The results showed that PowerPoint presentation has a significant influence on students' self-efficacy, attitude and academic achievement in the university than the traditional method.

Yumusak, Maras and Sahin (2015), used computer assisted instruction with conceptual change texts (CAI+CCT), and use of traditional teaching method (TTM) on removing the misconceptions of science teacher candidates on the subject of radioactivity. it was found out that CAI+CCT were more successful than traditional teaching method in terms of removing misconceptions on radioactivity

Sentongo, Kyakulaga and Kibirege (2013) researched to examine the effect of computer simulations in addition to 'hands-on' (manual) laboratory activities when teaching chemical bonding to compare the results to those of learners who were taught using hands-on (manual activities) only. The study which was carried among 105 senior secondary form three students in Uganda proved that computer simulations provide feedback that reduces abstractions. Analysis of data from the achievement test showed that computer simulations lead to enhancement of learners' understanding of abstract chemistry concepts and allowed learners to visualize chemical reactions at a microscopic level. The results further suggested that computer simulation enables learners to create clearer representations of chemical reactions much better than the traditional teaching can do. Also, Nwanne and Agommuoh (2017) studied the effect of CAI on students' interest and achievement in Physics in Imo State, Nigeria. Using purposive sampling, 97 second year students were drawn from two government senior secondary schools. The result of the analysis showed that CAI had significant effects on students' interest and achievement in physics. Results of the research

further suggested that computer-assisted teaching was more effective than teacher-centred methods to increase academic achievement.

Khan and Shah (2015) investigated the comparative effectiveness of multimedia-aided teaching on students' academic achievement and attitude at the elementary level in teaching science among 60 eighth grade pupils in Karachi. T-test showed a significant difference in achievement scores of control and experimental groups. The results of the study therefore showed that multimedia-aided teaching is more effective than the traditional one. The study further suggested that multimedia-aided teaching could be an effective method for cognitive and attitude development of students than the traditional one. The study also showed that multimedia-aided teaching helps develop higher-order thinking skills and appeal to students psyche towards learning; this was aided by the use of simulations, sound and video clips, making lessons attractive and effective.

Simulations are good methods that imitate complex real-life situations that make students' learning easier. , Ezeudu and Okeke (2013) conducted quasi-experimental research with 159 senior secondary students to investigate the effect of simulation on students' achievement in secondary school chemistry in Enugu East Local Government Area in Nigeria. The results show that students taught using computer simulation got higher mean scores in Chemistry than those taught with the conventional method. Similarly, Efe and Efe (2011) evaluated the effect of computer simulation on secondary school biology instruction involving 91 students. Analysis of posttest scores showed that students taught with the help of computer simulations were more successful in answering questions related to cell unit compared to students who were taught with traditional methods. The results further revealed that students taught with computer simulation outperformed their colleagues in all six cognitive levels of Bloom's taxonomy; knowledge, comprehension, application, analysis, synthesis and evaluation in Turkey. Njoku and Phoebe (2014) undertook research to use computer simulation animation strategies to resolve identified Nigerian students' learning difficulties in nuclear chemistry concepts. Four weeks of treatment was given to 63 Senior Secondary Form III students. The study concluded that computer simulation animation strategies reduced the widespread learning difficulties experienced by the participants.

CAI and Students' Higher Order Thinking Skills
Several studies have shown that when technology is integrated into classroom instructions, there are several advantages; technology can produce an environment that promotes higher-order thinking skills (Kurt, 2010). In their study on the effectiveness on the integration of ICT in schools, Ghavifekr and Rosdy (2015) found that when ICT is effectively integrated with teaching and learning, it promotes active student engagement and enables students to learn effectively. Furthermore, ICT helps students to be more creative and imaginative. According to Keser, Huseyin and Ozdamli (2011), technology can further increase learner collaboration which is an effective approach for learning.

Information technology has been identified as an approach that enables acquisition of higher-order thinking skills. According to Efe and Efe, (2011), many genres of IT can be used creatively to improve the thinking processes of students. Particularly, computer simulation stands out as having a high potential for the acquisition of higher-order thinking skills. Computer simulation is effective in promoting science content knowledge, developing process skills and facilitating conceptual change (Smetana & Bell, 2012).

The educational uses of information technology can be categorized into learning from computers, learning about computers and learning with computers. Simulations fall into the category of learning with computers and Zach (2020) termed simulations as tools for acquiring effective practical, substantial and relevant knowledge. The development and use of simulation in teacher education is to create a situation that resembles real-world behaviors. Therefore simulations as CAI are capable of addressing higher levels of student thinking such as analysis, synthesis and evaluation (Zach, 2020).

Methodology of the Study
This section presents the description of the research design, participants and sampling techniques. It also discusses about the instrumentation, treatment of data and gives a description of data analysis.

Research Design
This study employed a quasi-experimental, non-randomized pretest-treatment-posttest design with one group. This design was appropriate for the study because the study was based on the assumption that students had been introduced to

the topic 'reaction rate' at the senior high school. Therefore students were assumed to have prior knowledge on the topic. The choice of quasi-experimental design was informed by the fact that on admission, students at the college of education were grouped into various classes. Hence using the intact classes already in place would prevent distortion of classes and the college's academic time table, which could have resulted from randomization of students for this research. Another reason that informed the choice of the design was the assertion that quasi-experiment aims to evaluate interventions that did not use randomization (Shadish, Cook & Campbell, 2002). Thus the design would permit the causal effect of the treatment which is the teaching method on the dependent variable namely students' conceptual change and achievement.

Participants
A total of one hundred and fifty (150) first year (level 100) students of St. Ambrose College of Education participated in the research. These students aged between 19 years and 28 years. Since the one group design was adopted, all participants were subjected to the same treatment using computer simulation plus the traditional approach to teach reaction rates.

Instrumentation
Reaction Rate Concept test (RRCT) was used as the data collection instrument. This test was developed to measure students' performance toward the rate of reaction concepts. The RRCT was prepared in the light of the instructional objectives of the lessons on the rate of reaction unit. Items were therefore constructed to measure participants' performance in the appropriate rate of reaction concepts. The items were also identified with the six levels of dimensions in the cognitive domain based on the Bloom's taxonomy of learning objectives. This was done to find out the effect of the treatment on students' ability to operate at the various cognitive levels of thinking.

Treatment
Treatment was carried out in three weeks, each lesson was in two sessions; in the first session, the researchers projected the simulations using PowerPoint combined with the traditional expository method. In this session, lessons proceeded in the Posner et al's (1982) model of conceptual change instruction. In the second session, the participants continued to interact with the computers at the computer laboratory where they were paired to a computer. This pairing was necessary because of an inadequate number of computers at the laboratory. Each lesson lasted for two hours.

Data Analysis
Data gathered were analyzed descriptively with regards to the research questions. Specifically, percentages and mean scores were used to analyze data through the SPSS and Microsoft Excel. A relationship between teaching approach as independent variable and learners' ability or performance of reaction rate concept test (RRCT) was also established.

Findings of the Study
This section presents the findings of the study based on the data analysis.

Students' Reaction Rates
Table 1 shows the test results of students in reaction rates test conducted before the implementation of treatment of computer-assisted instruction strategy. The scores indicate a high level of incorrect responses of items by students in the test and a very low percentage of participants scored various items correctly. For instance, as low as 13.3% of participants had item 16 correct. Also, questions 4, 6, 9, 14 and 26 each had only 20% of participants scoring it correctly. Other items that had a low percentage of participants scoring correctly were item 1 which had 46.7% of students scoring it correctly and item 3 which was correctly scored by 30.7% of participants. Item 5 was correctly scored by 39.3% of participants, item 7 was scored by 22.7% and item 13 was scored by only 21.3% of participants. These figures indicate how poorly students performed in the reaction rate concept test carried out before treatment. Table 1 further indicates that only one item (question 11) had about 50.7% of students scoring it correctly, in the pretest. The table further shows that an average of 28.7% of students who took part in the pretest scored items correctly while 71.3% of the students failed to score items correctly.

The performance of the students improved in the posttest which was conducted after the treatment with the CAI strategy. Table 1 indicates a high level of improvement in terms of the percentage of students who scored various items correctly. For example, as much as 78.0% of participants scored item 7 correctly. Again, 73.3% of participants scored

item 1 correctly. Generally, the percentages of participants who scored various items correctly in the post test session were high as compared to the pretest scores. For instance, the percentages of participants who scored item 2 correctly were 69.3%, item 5 was scored by 57.3% of participants, item 6 was scored by 73.3%, and item 10 was scored by 66.7% of participants.

Table 1: Reaction Rate Achievement Test

	PRE-TEST		POST-TEST	
SN	Correct Response (%)	Incorrect Response (%)	Correct Response (%)	Incorrect Response (%)
1	70(46.7)	80(53.3)	110(73.3)	40(26.7)
2	65(43.3)	85(56.7)	104(69.3)	46(30.7)
3	46(30.7)	104(69.3)	81(54.0)	69(46.0)
4	30(20)	120(80)	79(52.7)	71(47.3)
5	59(39.3)	91(60.7)	86(57.3)	64(42.7)
6	30(20)	120(80)	110(73.3)	40(26.7)
7	34(22.7)	116(77.3)	117(78.0)	33(22.0)
8	34(22.7)	116(77.3)	105(70.0)	45(30.0)
9	30(20.0)	120(80.0)	82(54.7)	68(45.3)
10	52(34.7)	98(65.3)	100(66.7)	50(33.3)
11	76(50.7)	74(49.3)	108(72.0)	42(28.0)
12	57(38.0)	93(62.0)	103(68.7)	47(31.3)
13	32(21.3)	118(78.7)	101(67.3)	49(32.7)
14	30(20)	120(80)	82(54.7)	68(45.3)
15	48(32.0)	102(68.0)	91(60.7)	59(39.3)
16	20(13.3)	130(86.7)	80(53.3)	70(46.7)
17	34(22.7)	116(77.3)	96(64.0)	54(36.0)
18	52(34.7)	98(65.3)	92(61.3)	58(38.7)
19	50(33.3)	100(66.7)	90(60.0)	60(40.0)
20	40(26.7)	110(73.3)	78(52.0)	72(48.0)
21	50(33.3)	100(66.7)	106(70.7)	44(29.3)
22	50(33.3)	100(66.7)	103(68.7)	47(31.3)
23	33(22.0)	117(78.0)	81(54.0)	69(46.0)
24	46(30.7)	104(69.3)	96(62.7)	54(37.3)
25	34(22.7)	116(77.3)	103(68.7)	47(31.3)
26	30(20)	120(80)	80(53.3)	70(46.7)
27	36(24.0)	114(76.0)	86(57.3)	64(42.7)
28	31(20.7)	119(79.3)	78(52.0)	72(48.0)
29	49(32.7)	101(67.3)	85(56.7)	65(43.3)
30	45(30.0)	105(70)	99(66.0)	51(34.0)
Mean	**Mean=28.7**	**Mean =71.3**	**Mean =62.4**	**Mean= 37.6**

Percentage in parenthesis

Again, while 61.3% of participants scored item 18, 68.7% scored item 25 and 52.0% scored item 28. It is clear from the table that item 16 which had as low as 13.3% of students scoring it correctly in the pretest, had 53.3% of students who scored it correctly in the posttest. The percentage of the average number of students who scored items correctly in the posttest was 62.4%, an improvement from 28.7% in the pretest.

Knowledge Dimension

Table 2 presents the analysis of student achievement in both pretest and posttest in the knowledge dimension in the cognitive domain of

Bloom's Taxonomy of learning. As observed, there was quite a fair achievement in the pretest in which 46.7% of the participants scored item 1 correctly while the percentage of candidates who scored items 2 correctly was 39.3%. Item 3 was correctly scored by 50.7% while item 4 was scored by 38.0%. A mean of 43.7 of participants scored items correctly in the pretest.

Table 2: Students' Scores in Knowledge Dimension

	Pre-test		Post-test	
Item	% of Correct Response	% of Incorrect Response	% of Correct Response	% of Incorrect Response
1	70(46.7)	80(53.3)	110(73.3)	40(26.7)
2	59(39.3)	91(60.7)	86(57.3)	64(42.7)
3	76(50.7)	64(49.3)	108(72.0)	42(28.0)
4	57(38.0)	93(62.0)	103(68.7)	47(31.3)
Mean	**43.7**	**56.3**	**67.8**	**32.2**

Percentage in parenthesis

Table 3: Students' Test Scores in the Comprehension Dimension

	Pre-Test		Post-test	
Item	%Correct Response	%Incorrect Response	%Correct Response	%Incorrect Response
1	65(43.3)	85(56.7)	104(69.3)	46(30.7)
2	46(30.7)	104(69.3)	81(54.0)	69(46.0)
3	52(34.7)	98(65.3)	100(66.7)	50(33.3)
4	48(32.0)	102(68.0)	91(60.7)	59(39.3)
5	52(34.7)	98(65.3)	92(61.3)	58(38.7)
6	50(33.3)	100(66.7)	90(60.0)	60(40.0)
7	50(33.3)	100(66.7)	106(70.7)	44(29.3)
8	50(33.3)	100(66.7)	103(68.7)	47(31.3)
9	46(30.7)	104(69.3)	96(62.7)	54(37.3)
10	45(30.0)	105(70)	99(66.0)	51(34.0)
Mean	33.6	66.4	64.0	36.0

Percentage in parenthesis

In the posttest, the percentages of participants who scored various items correctly increased. For example, 73.3% of participants scored item 1 correctly, 57.3% scored item 2 correctly and 72.0% scored item 3 correctly. Again 68.7% of participants scored item 4 correctly. As observed, there was an improvement in participants' achievement in the post- test results. The percentage of the mean number of candidates who scored various items correctly was 67.8% in the post-test against 43.0% in the pretest. This finding suggests that the treatment has been effective in improving achievement.

Table 3 presents 10 items that measured comprehension dimension. Item 1 was scored by 43.3% of participants, item 2 by 30.7%, item 3 by 34.7%, item 4 by 32.0%, and item 5 by 34.7% correctly. Again, item 6 was scored by 33.3%, item 7 by 33.3%, item 8 by 33.3%, item 9 was scored by 30.7% and item 10 was scored by 30% correctly. The figures further show that in the pretest, item 2 was scored correctly by the highest number of students (43.3%) suggesting that most of the students did not score items correctly in the pretest. The pre-test correct responses had the mean score of 33.6% as compared to the mean score of 64% in the post test results.

In the post-test, the percentages of participants who scored items correctly ranged from 54% to about 71% with a mean of 64.0% for participants who scored the items correctly. The table suggests that there was an improvement in the achievement of participants. Detailed observation of Table 3 indicates that the percentage of candidates who scored item 1 correctly in the posttest was 69.3%. Item 2 was scored correctly by 54.0%, item 3 was scored by 66.7%, item 4 was correctly scored by 60.7%, item 5 by 61.3%) and item 6 by 60.0%. Table 3 further shows that 70.7% of participants scored item 7 correctly, 68.7% scored item 8 correctly,

62.7% of participants scored item 9 correctly and 66.0% scored item 10 correctly. Since the post-test was conducted after participants were taken through CAI treatment, the gains in achievement can be attributed to the use of the CAI approach.

The Application Dimension

Table 4 shows that items that measured the application dimension were 1, 2, 3, 4 and 5. In the pretest, 20% scored item 1 correctly, 20% scored

item 2 correctly, 22.7% scored item 3 correctly, 20% scored item 4 correctly and 13.3% scored item 5 correctly. The highest number of participants who scored an item correctly was 22.7% for item 3 while item 5 received the lowest score of 13.3%. The average for items scored correctly in this category was 19.2% which is low as compared to the post-test results with 62.4%.

Table 4: Students Performance in the Application Dimension

Item	Pre-test		Post-test	
	Correct Response (%)	Incorrect Response (%)	Correct Response (%)	Incorrect Response (%)
1	30(20)	120(80)	79(52.7)	71(47.3)
2	30(20)	120(80)	110(73.3)	40(26.7)
3	34(22.7)	116(77.3)	117(78.0)	33(22.0)
4	30(20)	120(80)	82(54.7)	68(45.3)
5	20(13.3)	130(86.7)	80(53.3)	70(46.7)
Mean	**19.2**	**80.8**	**62.4**	**37.6**

Percentage in parenthesis

Table 5: Students Performance in the Analysis Domain

Item	Pre –test		Post-test	
	% of Correct Response	% of Incorrect Response	% of Correct Response	% of Incorrect Response
1	34(22.7)	116(77.3)	105(70.0)	45(30.0)
2	33(22.0)	117(78.0)	81(54.0)	69(46.0)
3	34(22.7)	116(77.3)	103(68.7)	47(31.3)
4	30(20)	120(80)	80(53.3)	70(46.7)
5	49(32.7)	101(67.3)	85(56.7)	65(43.3)
Mean	**24.0**	**76.0**	**60.5**	**39.5**

Percentage in parenthesis

In the posttest, the average of participants who scored various items correctly increased to 62.4% up from 19.2% in the pretest. Judging from Table 4, it is clear that there has been a high improvement in the post-test results.

Table 5 shows that items that measured analysis dimension were 1, 2, 3, 4 and 5. The mean of candidates who scored the various items correctly were 22.7% for item one, 22.0% scored item two correctly, 22.7% for item three, 20.0% for item four and 32.7% for item five. Thus the percentage of the highest number of candidates who scored items correctly was 32.7% while the lowest percentage was 20.0%. The overall average of participants who scored an item correctly was 24.0% which is a low figure indicating a poor performance in the pretest.

Table 5 further shows improved achievement in the posttest. The percentage of the highest and lowest correct scores were 70% and 53.3% respectively. The percentage of the average number of participants who scored an item correctly was 60.5%, which is an improvement from the 24.0% in the pretest. Results further indicate that the percentage of participants who scored correctly item 1 was 70%, item 2 was 54.0%, item 3 was 68.7% and item 5 was 56.7%. This clearly shows that CAI is an effective method in enhancing students' performance in the analysis domain.

The Synthesis Dimension

In Table 6, items 1, 2 and 3 measured the synthesis dimension. In the pretest, the percentages of participants who scored the items correctly were 20%, 21.3% and 26.7% respectively. The percentage

of the mean number of participants who scored items correctly was 22.7%. This indicates that just a few of the participants scored items correctly in the pretest.

Table 6: Students Performance in the Synthesis Dimension

	Pre-test		Post-test	
Item	% of Correct Response	% of Incorrect Response	% of Correct Response	% of Incorrect Response
1	30(20.0)	120(80.0)	82(54.7)	68(45.3)
2	32(21.3)	118(78.7)	101(67.3)	49(32.7)
3	40(26.7)	110(73.3)	78(52.0)	72(48.0)
Mean	22.7	77.3	58.0	42.0

Percentage in parenthesis

Table 7: Students Performance in the Evaluation Dimension

	Pre-test		Post-test	
Item	% of Correct Response	% of Incorrect Response	% of Correct Response	% of Incorrect Response
1	34(22.7)	116(77.3)	96(64.0)	54(36.0)
2	36(24.0)	114(76.0)	86(57.3)	64(42.7)
3	31(20.7)	119(79.3)	78(52.0)	72(48.0)
Mean	**22.5**	**77.5**	**57.8**	**42.2**

Percentage in parenthesis

In the posttest, there was an enhanced performance because most of the participants scored items correctly. A look at the figures indicates that the percentage of participants who scored various items correctly was 54.7% for item one, 67.3% for item two and 52.0% for item three. The percentage of the average number of participants who scored items correctly was 58.0%, an improvement of 36.7% over the pretest performance.

The Evaluation Dimension
Table 7 presents results on the evaluation dimension. In the pretest, participants ' achievements were low as the percentage of candidates who scored the items correctly was 22.7% for item one, 24.0% for item two and 20.7% for item 3. The percentage of the mean number of participants who scored an item correctly was 22.5%. The posttest values show an improvement over the pretest. In the posttest, the percentages of the number of participants who scored items correctly were 64.0% for item one, 57.3% for item two and 52.0% for item three. The percentage of the average number of participants who scored items correctly was 57.8%, an improvement over the 22.5% average in the pretest.

Discussion
The purpose of the study was to compare the use of computer assisted instruction with the traditional teaching method to determine the achievement on reaction rate in the integrated science. In the posttest, scores of participants showed a significant positive effect of the CAI in the RRCT because there was a high improvement as compared to the pretest scores. Results indicate that the CAI is the appropriate conceptual change oriented instruction since there was a significantly high level of acquisition of scientific concepts related to rate of reaction in that approach. The reason for the significant high level of students' understanding of concepts in the posttest may be attributed to the use of the CAI strategy.

The findings are inconsistent with those of Owusu et al, (2010) that the use of CAI is not superior to conventional methods of teaching for student achievement. However, the findings are in harmony with those of Aina (2013) which suggested gains in student understanding and achievement when the CAI is adopted as instructional method in the science subjects.

When the CAI was used as treatment strategy, it resulted in a higher achievement in the post test results with the percentage of average number of students who scored response correctly being 62.4% up from the 28.7% of the pretest whereby there was a 33.7% increase in achievement. The findings are in line with those of Khan and Shah (2015) who conducted a study about the comparative effectiveness of multimedia-aided teaching on achievement in science and reported that the

multimedia-aided teaching is more effective than the traditional teaching in science achievement.

The higher level achievement observed in participants after their exposure to the CAI also agrees with findings of Njoku and Phoebe (2014) who concluded that using computer simulation animation strategies reduced widespread teaching difficulties experienced by students in Nigeria. Their findings further indicate that computer assisted instruction reduces abstraction among students and makes it possible for them to effectively visualize abstract concepts. Thus, students are able to improve their conceptual understanding of science concepts.

The findings further confirm the conclusions of a study conducted by Ezeunu and Okeke (2013) that students taught with the computer assisted instruction outperformed those taught with the traditional teaching approach thereby simulation increased students' achievement in chemistry more than when the conventional method was used in Enugu East Local Government Area in Nigeria.

The findings also endorse the active learning assumption of Mayer (1989) and Paivio (1986) that meaningful learning occurs when learners engage in active cognitive processing by interacting with relevant words and pictures and organizing them into meaningful mental pictures. According to Paivio (1986), when the CAI is effectively presented, it creates the needed interest, curiosity and motivation for students which causes active participation leading to improved achievement, conceptual change and high cognitive achievement. Therefore, the high performance among students in the posttest could also be attributed to the interest and motivation students had from the CAI strategy.

Findings with respect to research question two show a significant increase in the students' achievement in the various domains after they were taught through the CAI. While the average percentage of students who got various items in the dimensions correct in the posttest is higher than that in the pretest, the finding confirms those of Sentongo, Kyakulaga and Kibirege (2013) which examined the effects of computer simulations in addition to hands-on laboratory activities in teaching chemical bonding and discovered that computer simulation with hands-on activities proved more effective in achievement in higher order thinking. Hence the CAI seems to have high benefits.

The findings again support those of Efe and Efe (2011) who evaluated the effect of computer simulation on secondary school biology instruction involving 91 students. Analysis of the posttest scores showed that students taught with the help of computer simulations were more successful in answering questions related to cell unit when compared to students who were taught with traditional methods. The results further revealed that students taught with computer simulation outperformed their colleagues in all six levels of Bloom's taxonomy. Therefore, what is your conclusion over this finding?

Conclusions

It is concluded that Computer assisted instruction is an effective approach to the teaching of the chemistry concepts as the use of the CAI as treatment to improve students' conceptual change and achievement yielded positive results. Secondly, students are motivated to learn effectively when computers and visual symbols are employed than when the conventional approaches are employed because abstract concepts are made more visible and real to the learners when the CAI is employed. This is justified by the fact that the participants made significant improvements in their post-test scores on all six levels (knowledge, comprehension, application, analysis, synthesis and evaluation) of Bloom's taxonomy. It is therefore concluded that the use of CAI to teach reaction rate and related topics helps students to do better in the higher levels of the domains of Bloom's Taxonomy.

Therefore the integration of computer assisted instruction with the conventional approach of teaching science has a better chance of improving student achievement in Chemistry because the use two methods together will mediate in the weaknesses of the other. In using such a strategy, the talk time of the teacher is reduced as the students personally interact with the instructional materials to uncover things for themselves.

Recommendations

Based on the findings of the study, it is recommended that teachers should use varied instructional approaches in teaching.. To this end, teachers should adopt computer simulations and other computer assisted instructional strategies for effective conceptual change lessons. Technology based instructions should therefore be integrated into the instructional processes especially when dealing with abstract concepts. Science teachers

should therefore consider the integration of computer assisted instructions into their classroom delivery especially when engaging students in activities to acquire higher order cognitive skills.

Reference

Abdul, K. G., & Shilna, V. (2013, November 21). *Role of concept cartoons in chemistry learning*.Retrieved from http://www.academia.edu/5646900/Role_of_concept_cartoons_in_chemistry_learning.

Adedamola, A. K. (2018). The use of multimedia in teaching biology and its impact on student learning outcomes. *The Eurasia Proceedings of Educational and Social Sciences (EPESS)*, 9, 157-165.

Adu-Gyamfi, K. (2014). Challenges faced by science teachers in the teaching of integrated science in Ghanaian junior high schools. *Journal of Science and Mathematics Education*, 6(2), 59-80.

Aina, J. K. (2013). Effective teaching and learning in science education through information and communication technology (ICT). *Journal of Research and Method in Education (IOSR-JRNA)*, 2(5), 24-27.

Amer, A. (2006). Reflections on Bloom's revised taxonomy. *Electron J. Res. Educ Psychology*, 4(8), 213-230.

Basili, J., & Sanford, P. (1991). Conceptual change strategies and cooperative group work in chemistry. *Journal of Research in Science Teaching*, 28(4), 293-204.

Bonarjee, A. (1991). Misconceptions of students and teachers in chemical equilibrium. *International Journal of Science Education*, 13, 487-494.

Boujaoude, S. B. (2000). Secondary students' difficulties with stoichiometry. *School Science Review*, 81(296), 193-206.

Cakir, M. (2008). Constructivist approaches to learning in science and their implications for science pedagogy: A literature review. *International Journal of Environmental and Science Education*, 3(4), 193-206.

Cetingul, P., & Geban, O. (2005). Understanding of acid-base concept by using conceptual change approach. *University Journal of Education*, 29, 69-74.

Chuephangnam, M. (2000, 8 6). *Analysis of misconceptions in chemistryof Mathayom Suksa 5 students*. Retrieved from http://www.grad.cmu.ac.th/abstract/2000/edu/abstarct/

Coll, R., & Treasgust, D. (2001). learners' mental models of chemical bonding. *Research in Science Education*, 31(6), 357-382.

Dole, J., & Sinatra, G. (1998). Conceptualising change in cognitive construction. *Educational Psychology*, 33, 109.

Efe, H., & Efe, R. (2011). Evaluating the effect of computer simulations on secondary biology: An alication of Bloom's Taxonomy. *Scientific Research and Essays*, 6(10), 2137-2146.

Erdemir, N. (2011). The effect of PowerPoint and traditional lectures on students' achievement in physics. *Journal of Turkish Science Education*, 8(3) 177-189.

Ezeudu, F., & Okeke, P. (2013). Effect of simulatiton on students' achievement in senior secondary school Chemistry in Enugu East Local Governemnt Area of Enugu State, Nigeria. *Journal of Education and Practice*, 4(19), 84-89.

Furo, T. (2015). Computer assisted instruction(CAI) and students' interest as determinant of SSII Chemistry students' achievement in chemical equilibrium in Rivers State. *IOSR Journal of Applied Chemistry (IOSR-JAC)*, 8(8), 50-56.

Geban, O., & Kaya, E. (2012). Facilitating conceptual change in rate of reaction concepts using conceptual change oriented instruction. *Education and Science*, 37 (163).

Ghavifekr, S., & Rosdy, W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Education and Science (IJRES)*, 1(2), 175-191.

Gregoire, M. (2003). Is it a challenge or a threat? A dual-process model of teachers' cognition and appraisal processes during

conceptual change. *Educational Psychology Review*, 15, 147-180.

Hanson, R. (2016). Ghanaian teacher trainee's conceptual understanding stoichiometry. *Journal of Educational and e-Learning Research*, 3(1), 1-8.

Johnstone, A. H. (1993). The development of chemistry teaching: A changing response to changing demand. *Journal of Chemical Education*, 70(9), 701-705.

Kesser, H., Huseyin, U., & Ozdamli, F. (2011). The trends in technology supported collaborative learning studies in 21st century. *World Journal on Educational Technology*, 3(2), 103-119.

Khan, M., & Shah, I. (2015). Impact of multimedia-aided teaching on students' achievement and attitude at elementary level. *US-China Education Review A*, 5(5), 349-360.

Kruse, J. (2010). Confronting doubts about the intelligibility, lausibility and fruitfulness of inquiry- based instruction. *Iowa Science Teachers Journal*, 37, 2-5.

Kurt, S. (2010). Technology use in elementary education in Turkey: A case study. *New Horizon in Education*, 58(1), 65-76.

Lin, J., & Chiu, M. (2007). Exploring the characteristics and diverse sources of students' mental models of acids and bases. *International Journal of Science Education*, 29(6), 771-803.

Mayer, R. (1989. Systematic thinking fostered by illustrations text. *Journal of Educational Psychology, 81*(4), 715-726

Nadelson, L., Heddy, B., Jones, S., Taasoobshirazi, G., & Johnson, M. (2018). Conceptual change in science teaching and learnig: Introducing the dynamic model of conceptual change. *International Journal of Educational Psychology*, 7(2), 151-195.

Nagao, M., Rogan, J., & Magno, M. (2007). *Mathematics and science education in developing countries: Issues, experiences and cooperation prospects.*
Diliman, Quezon City: University of the Philippines Press.

Nazimuddin, S. (2015). Computer assisted instruction (CAI): A new approach in the field of education. *International Journal of Scientific Engineering Research*, 3(7), 185-188.

Ngozi, M., & Norman, R. (2006). *Factors influencing curriculum development in chemistry.* UK: Royal Society of Chemistry.

Njoku, Z., & Phoebe, I. (2014). *School students' learning difficulties in Nuclear Chemistry using computer animations and solutions.* Retrieved from http://www.sciencedirect.com.

Nwanne, S., & Agommmuoh, P. (2017). Computer assisted instruction (CAI) on students' interest and achievement in Physics in Imo State, Nigeria. *IOSR Journal of Research & Method in Education (IOSR-JRME)*, 7(3), 53-58.

Owusua, K., Monney, K., Appiah, J., & Wilmort, E. (2010). *Effect of computer-assisted instruction on performance of senior high school biology students in Ghana*. Retrieved from http://www.elsevier.com/locate/compedu.

Ozdemir, G., & Clarke, D. (2007). *An overview of conceptual change theories*. Retrieved from http://www.ejmste.com/v3n4/EJMSTE-v3n4-ozd.

Ozdemir, O., & Oner, E. (2015). The effect of simulations and animations on students' motivation in a computer course. *Participatory Educational Research (PER)*, 11, 53-59.

Ozmen, H. (2008). The influence of computer assisted instruction on students' conceptual understanding of chemical bonding and attitudes towards chemistry: A case study for Turkey. *Computers and Education*, 51, 423-438.

Paivio, A. (1986). Mental representations: A dual coding approach. New York: Oxford University Press.

Ozmen, H., & Ayas, A. (2003). Students' difficulties in understanding of conservation of matter in

open and closed-system chemical reactions. *Chemistry Education: Research and Practice*, 4(3), 279-290.

Pine, K., Messer, D., & John, K. (2001). Children's misconceptions in primary science: A survey of teachers' views. *Research in Science and Technological Education*, 19(1), 79-96.

Posner, G., Strike, K., Hewson, P., & Gertzoge, W. A. (1982). Accommodation of scientific conceptions: Towards a theory of conceptual change. *Science Education*, 66(2), 211-227.

Saini, R. (2014). A flashback on computer assisted instruction (CAI). *International Multidisciplinary Research Journal*(VII), 1-7.

Saminathan, B. (2012). Effect of computer based instructional strategies in learning chemistry at higher secondary school level. *International Conference on Software and Computer Application (ICSCA).* Singapore: IACSIT Press.

Sentongo, J., Kyakulaga, R., & Kibirige, I. (2013). The efeect of using computer simulations in teaching chemical bonding: Experience with Ugandan learners. *International Journal of Educational Science*, 5(4), 433-441.

Shadish, W., Cook, D., & Campbell, D. T. (2002).*Experimental and quasi experimental design for generalizing causal inference .* Boston: Houghton Muffins.

Smetana, L., & Bell, R. L. (2012). Computer simulations to support science instruction and learning: A critical review of literature. *International Journal of Science Education*, 34, 1337-1370.

Sungur, S., Tekkaya, C., & Geban, O. (2001). The contribution of conceptual change texts accompanied by concept mapping to students' understanding of the human circulatory system . *School Science and Mathematics*, 101(2), 91-101.

Susskind, J. (2007). Limits of the powerpoint's power: Enhancing self-efficacy and attitudes but not their behaviour. *Computer and Education*, 50(4), 1228-1239.

Talanquer, V. (2011). Macro, submicro and symbolic: The many faces of the chemistry triplet. *International Journal of Science Education*, 33(2), 179-195.

Tilahun, K., & Tirfu, M. (2016). Common difficulties experienced by grade 12 students in learning chemistry in Ebinat Preparatory School. *African Journal of Chemical Education -AJCE*, 6 (2), 16-32.

Tolbert, E. J. (2015). *The impact of computer- aided instruction on student achievement*. Retrieved from Education Dissertation and Projects: http://digitalcommons.gardner-webb.edu/education_etd/127.

Treagust, D., Nieswandt, M., & Duit, R. (2018). Sources of students' difficulties in learning chemistry. *Education Quimica*, 11, 228-235.

Verkade, H., Mulher, T., Lodge, J., Elliot, K., Cropper, S., Rubinstein, B., Livett, M. (2017). *Misconceptions as a trigger for enhancing student learning in higher education: A handbook for educators.* Melbourne: The University of Melbourne.

Yeboah, R., Abonyi, K., & Luguterah, W. A. (2015). Making primary school science education more practical through appropriate interactive instructiona resources: A case study of Ghana. *Cogent Education*, 6, 1.

Yumusak, A., Maras, I., & Sahin, M. (2015). Effect of computer assisted instruction with conceptual change texts on removing the misconceptionsnof radioactivity. *Journal for the Education of Gifted Young Scientists*, 3(2), 23-50.

Zach, S., & Ophir, M. (2020). Using simulation to develop divergent and reflective thinking in teacher education. *Sustainability*, 12, 2879.