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The Effects of Integrating Information and Communication Technology (ICT) In Teaching the Atomic Structure in Chemistry among Senior High School Students

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Abstract: This research work looks at the effects of incorporating technology (I.C.T) into the educational curriculum most especially in chemistry and how it affects the teaching and learning of the atomic structure in the senior high schools. The study made used of an experimental design in the data collection. The overall students for this study were eighty one (81) S.H.S Chemistry Students in Our Lady of Lourdes Girls' Senior High School but the researcher worked with fifty six (56) of them in the same year group. The sampling was done by using a shuffled list and assigning every second person to one group and the others to a different group. Multiples-choice and fill-in the blank questions were used for the data collection. The test was conducted before as pretest and after as posttest for the two groups respectively. From the mean, standard deviation and the t-test, (t-value of -3.434) there was a significant difference in the mean scores of the students taught using the I.C.T integrated method. Per this findings, chemistry educators or teachers are encouraged to integrate I.C.T in the teaching and learning processes of the atomic structure. Chemistry students should be challenged to use the internet and other technological mediums in their learning and doing of assignment especially in the topic, atomic structure. This will help them to be familiar with the use of I.C.T tools and how to use them in their learning processes.

Keywords: Technology, Integration, Communication, Transformed, Information, Chemistry, Atomic structure, incorporate.

I. Introduction

Teaching methods to a large extend serve as the pivots where students understanding of the various subjects revolved. How well technology which is a teaching method could be incorporated in teaching the scientific principles in the topic, atomic structure, founded in the educational curriculum still remains a challenge (Akpan, 2010). A variety of technological procedures are used to complement the course curriculum, providing students with additional resources such as study questions, assessments, and activities that can help them to appreciate teaching and learning inside or outside of the classroom (Mustapha, 2018).

Chemistry, as a crucial subject in Ghanaian senior high schools, poses challenges for students in understanding and applying concepts without making the learning practical(Kassim, 2014). The teaching of chemistry in high schools is bemoaned with obstacles, including inadequate infrastructure and technical personnel, hindering effective sessions (Arokoyu & Ugonwa, 2012). Researchers, educators, and teachers acknowledge chemistry's difficulty due to abstract concepts and challenging language, leading to alternative conceptions among students (Cardellini, 2012). Some methods used in teaching includes: Lecture method, problem-solving activities, case study among others. These methods do not employ any I.C.T tool and therefore the need to include I.C.T in teaching, most especially chemistry and in teaching the atomic structure, to despite the abstract nature of the topic. The integration of Information and Communication Technology (ICT) in education would significantly transformed the learning landscape, particularly in the teaching of the atomic structure which has to do with discoveries and behavior of particles. Through videos presentations the students can appreciate the behavior of electrons which informed the various discoveries. Also, students with various challenges (eyes issues, hearing issues e.t.c) could be taken care of by the use of I.C.T in different ways.

This study investigates how I.C.T influences students' understanding and academic performance in the atomic structure in chemistry. By employing innovative teaching methods, I.C.T enhances engagement, facilitates interactive learning, and supports diverse learning styles.

II. Literature review

Contemporary behavioral and educational experts agree that learning follows structured ways, with specific application within each stage. Adam (2002) simplifies this process, identifying three stages in understanding the occurrences these are, the building stage, development stage, and practice stage. The learning stages, as per modern educational theory, aligns with Birdstall's(2005) explanation that theoretical teaching primarily occurs in the building stage, which has the least time investment. According to Birdstall (2005), at the development and practice stages, understanding of the phenomenon and perfection of learning are respectively developed. Also, Broadhead (2010) underscores the gradual reduction of the teacher's involvement from the building to the practice stage. Cortes (2000) asserts the paramount importance of the practice stage in culminating the learning process, receiving extensive attention from educators worldwide. Fabian (2009) advocates for students' initiative and judgment during the

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practice stage, contrasting with traditional teaching methods prevalent in underdeveloped and developing countries. In these nations, the active participant in the learning is rather the instructor and at the practice stage, this is contrary to modern teaching approaches. According to Ives (2001), contemporary teaching methods, the active participants should be the learners, with the teacher being a mentor or guide. The practice stage of learning employ three extensive methods which include the behavior-controlled practice method, mutual practice method, and team practice method

Students' Interest in Chemistry

Interest, as defined by Van Den Branden (2015) is the likelihood to invest energy in specific stimuli which plays a pivotal role in students' academic engagement. He emphasized on the positive correlation between student interest and learning. Despite this, global studies have shown that, the interest of the students in senior high schools in Ghana depreciated drastically in learning the sciences, particularly physics and chemistry, with factors contributing to this decline still unclear (Hasni & Potvin, 2015). Research indicates a significant decrease in interest as students' progress through secondary school, especially notable for girls (Grabau, 2017). Additionally, the perception of science subjects as difficult has risen, accompanied by a persistent decline in post compulsory high school science enrollment worldwide (Hasni & Potvin, 2015).

Teaching methodologies and outcomes on students' learning

Nbina & Obomanu (2011), said that, the achievement of instructional objectives is a prove of the progress of teaching and learning. In the Ghanaian high schools the lecture method of teaching is mostly used (Ibe &Madu,2004). This makes teaching and learning so abstract to comprehend especially in science. In as much as there is no one best method of teaching, the activity method and the I.C.T integrated method of teaching could be more effective than the usual teaching methods.

Conceptual Understanding in Chemistry

Conceptual understanding simply means understanding of certain concepts that is, the ability to construct one's own meaning or knowledge about a concept. Frailich, Miri & Avi (2008) works on chemical bonding proves that, students understanding to a large has to do with how they included in the learning process taking into consideration their emotions, gender as well as those with developmental challenges i.e. hearing or seeing problems. The use of I.C.T as a new approach would effectively take care of most of these issues while teaching and learning goes on. According to Stefani & Tsaparlis (2009) works on the construction of basic quantum chemistry concepts, there is a poor understanding of basic chemistry concepts. Base on his findings, there is therefore the need to change the approaches to teaching and learning in our high schools. Teaching methods helped students to get better conceptual understanding and be able to keep the learning (Costus, Alipasa & Mansoor 2009). Also, Marchlewicz & Wink (2011) works revealed that, the activity model of inquiry helps to enhance general chemistry students understanding of the nature of science. Brett (2012) works on scaffolding a method of teaching to enforce inquiry skills in students proves to give good results. He therefore, suggested that, per the subject and the area a teachers should incorporate it in their lessons delivery. All of these teaching approaches are gearing towards making the learning of chemistry practical. I.C.T if integrated well, will not only make learning easy, but will serve as a new method which would always make students see the reality and not to imaging things especially, the atomic structure and the discovery of the electrons in chemistry.

Problem-solving Skills in Chemistry

Danjuma (2005) defines A problem is a situation that confront a person, a group, country or otherwise for which an immediate answer or solution is not available. A problem-solving skill therefore is a process whereby an individual or a group uses previously acquired knowledge and skills to solve a problem (Danjuma 2005). According to Danjuma (2012), the concept of a problem must be a challenge to the solver who is willing to accept the challenge and finding ways of obtaining the solution to the challenge or problem. Therefore, the is the need for change in the instructional approaches to teaching chemistry so as to not make the subject liked by the students but to let them love the subject.

Challenges of Integrating I.C.T in teaching in the Classrooms

The significance of I.C.T cannot be overlooked today and even in the future. It is therefore very necessary to integrate or include this technology in our teaching and learning processes in the various schools more so in the high schools. According to Walker (2011), moderate technical skills, self-motivation to engage in instructional technology, supportive peer communication channels and flexibility in delivery a planned lesson are but some challenges that militates against a successful integration of I.C.T in our teachings and learning in our Ghanaians high schools. The integration of I.C.T in the school system depends on the following; availability of I.C.T tools, the competence and attitude of teachers, the availability of good computer labs and lighting system (Chattel, 2002; Cheng, 2003; Chiemeke, 2004). The lack of adequate skills I.C.T teachers and accessible points in the schools is preventing the use of internet by high school teachers (Adoni & Kpangban, 2010). Also, Akindoju, Banjoko, & Avoseh, (2011) identified the inadequate computer hardwares and softwares as factors preventing I.C.T integration in the classroom. He added that, the problem is because of there is no budget allocation for that purpose. From Ozoji (2003) research work, some high schools have few computers however, they do not have software for the computer to function.

Teachers all over the Ghanaian high schools have high enthusiasm towards the integration of I.C.T in their lesson delivery but the challenge therefore is they do not have any training on the basic computer operations and the computer softwares as well (Yusuf, 2005).

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III. Methodology

Research Design

This research work made used of an experimental design, which utilized pretest and posttest to show the relationship between the effects of the various treatments. This particular design gives room for comparison of the pretest achievement among different groups for the establishment of internal validity of the participating groups. It also gives room for the researcher to determine the treatment effect using the posttest achievement.

Research Method

The study made used of quantitative data. The researcher crafted thirty objective questions, including fill-in the blank questions on the topic, atomic structure. The scripts of the two groups were marked and recorded as the pretest scores. The experimental group made-up of twenty-eight students were giving an intervention (I.C.T incorporated method of teaching) for a week and the students in the control group were taught using the usual methods. Equivalent questions were set from the same topic and used after the intervention for both the control and the experimental groups.

Target population

Population has been defined to represent a whole from which a sample can be obtained from by a researcher (Taherdoost, 2016). Also, Rubin & Babbie (2009) said that a population represent a large group of peoples or individuals that have common characteristics and from which a researcher can draw a sample for study purpose.

The target population for this study was all S.H.S elective chemistry students in the Kasena Nankana Municipal in the Upper East Region of Ghana. However, the accessible population comprises of S.H.S One (1) Chemistry Students from Our Lady of Lourdes Girls' Senior High School (O.L.L.Girls) in the Kasena Nankana Municipal.

Sample and Sampling

The students were divided into two equal groups. This was done by assigning every second person in the shuffled list to the experimental group and the rest to the control group. The usual methods were used in a class of twenty-eight students (the control group) and the I.C.T incorporated method was also used in the other class of twenty-eight (28) students (the experimental group).

IV. Results and Discussion

This section consists of eight (8) tables. The tables shows the analysis of the test results obtained from the students. The means of the results were compared and the sample t-test analyzed at p-value of 0.05. The data was run using the SPSS software.

Table 1: compares the pretest mean scores of the experimental group and the control group.

Table 1: Group statistics for pretest scores of the experimental and control groups.

Groups	N	Mean	Std. Deviation	Std. Error Mean
Experimental group	28	47.71	14.16	2.68
Control group	28	48.64	16.78	3.17

From Table 1, the mean scores for both the pretests results of the experimental group and the control group are 47.71 and 48.64 respectively. The mean difference between the two groups is 0.93. This difference is not much, and therefore the two groups were equivalent in term of their academic performance before the intervention. Also, the standard deviation and standard error of means for the experimental group are respectively 14.16 and 2.68. The 16.78 and 3.17 are the standard deviation and standard error of means scores for the control group. The slightly higher standard deviation in the control group (16.78) suggests a wider range of performance compared to the experimental group.

Table 2 is a statistical analyses of the sample t-test for the pretests scores of both the experimental group and the control group. The analyses on the table seek to find out whether there is a significant difference between the two groups pretest results.

Table 2: Sample t-test for pretest scores of experimental and control groups.

Levene's Test for Equality of Variances			t-test for Equality of Means						
	F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.35	.56	-.22	54	.82	-.93	4.15	-9.23	7.39
Equal variances not assumed			-.22	52.51	.82	-.93	4.15	-9.26	7.39

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From Table 2, there is a t- value of -0.22. The lower and upper values are: -9.23 and 7.39 respectively. The t-value of -0.22 lies within the lower and upper values indicating no statistically significance. The p-value (0.82) is greater the confidence level of 0.05, this shows that there is no statistically significance difference between the pretest scores of the two groups and it confirms that two the groups were comparable in terms of their academic performance before the intervention.

Table 3 is the group statistic which mainly compares the mean scores of the pretest and posttest of the experimental group.

Table 3: Group statistics for experimental group pretest and posttest scores

Test	N	Mean	Std.Deviation	Std. Error Mean
Pretest	28	47.71	14.16	2.68
Posttest	28	61.96	16.79	3.17

From Table 3 the mean scores for the pretest and posttest results of the experimental group are 47.71 and 61.96. There is a mean difference of 14.25 between the two tests administered. This difference suggests an increase in the students' performance. This increments is significant with the highest mean scores been after the intervention, it means that the intervention has help in uplifting the students' performance. The variability in the level of improvement among the students is indicated by the high standard deviation (16.79) in the posttest scores.

Table 4 is a statistical analyses of the sample t-test for the pretest and posttest scores for the experimental group. The analyses on the table seek to find out whether there is a statistically significant difference between the two set of scores.

Table 4: Sample t-test for the experimental group pretest and posttest scores

Levene's Test for Equality of Variances			t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	1.26	.27	-3.43	54	.001	14.25	4.15	-22.57	-5.93
Equal variances not assumed			-3.43	52.51	.001	14.25	4.15	5.92	22.56

From Table 4, the t- value (-3.43) lies outside of the lower (22.57) and upper (-5.93) values. The t-value of -3.43 lies outside of the lower and upper values. This confirms a significant increase in the posttest scores as compared to the pretest scores. The test was analyzed at a p-value (0.001) is closure to zero and is it less than 0.05 which is the confidence level. This further validates the significance of the improvement.

The Table 5 is the group statistic which mainly compares the mean scores of the pretest and posttest scores of the control group.

Table 5: Group statistics for control group pretest and posttest scores.

Test	N	Mean scores	Std. Deviation	Std. Error Mean
Pretest	28	48.64	16.78	3.17
Posttest	28	53.43	14.11	2.67

From Table 5, the mean scores for the pretest and posttest results of the control group are 48.64 and 53.43. There is a mean difference of 4.79 between the two tests administered. This difference is statistically negligible suggesting that there is no much change in the students' performance over the period of time. The standard deviation and standard error of means of the pretest mean scores for the control group are respectively 16.78 and 3.17. The 14.11 and 2.67 are the standard deviation and standard error of means scores of the posttest for the control group respectively.

The Table 6 shows a statistical analyses of the sample t-test for the pretest and the posttest scores of the control group. The analyses on the table seek to find out whether there is a significant difference between the pretest and posttest results.

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Table 6: Sample t-test for control group pretest and posttest.

Levene's Test for Equality of Variances			t-test for Equality of Means						
	F	Sig.	T	Df	Sig.(2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.33	.57	-1.16	54	.25	-4.79	4.14	-13.10	3.53
Equal variances not assumed			-1.16	52.47	.25	-4.79	4.14	-13.10	3.53

From Table 6, the p-value is 0.25. This value is greater than the confidence level of 0.05 indicating no statistically significant difference between the pretest and the posttest scores of the control group. The t- value of -1.16 supports that that the non-I.C.T integrated method of teaching the atomic structure did not leads to any meaningful performance increase.

The Table 7 is the group statistic which mainly compares the mean scores of the posttest for both the experimental and the control groups.

Table 7: Group statistics for posttest scores of I.C.T integrated and control groups.

Groups	N	Mean	Std. Deviation	Std. Error Mean
I.C.T integrated	28	61.10	16.79	3.17
Control groups	28	53.43	14.11	2.67

From Table 7, the mean scores for the posttest results of both the I.C.T integrated method of teaching (experimental group) and the control groups are 61.10 and 53.43respectively. There exist a mean difference of 8.54 between the two tests administered to the two groups of students at the same time. The mean difference is significant. This shows that two teaching methods do not have the same impacts on the students' academic performance. The standard deviation and standard error of means for the posttest of experimental group are, 16.79 and 3.17. Also, from the table, the standard deviation and standard error of means for the control group are, 14.11 and 2.67.

Table 8 shows a statistical analyses of the sample t-test of the posttest scores for both the experimental and the control groups. The analyses was to find out whether there is a significant difference between the posttest results of the two groups.

Table 8: Sample t-test for posttest scores of I.C.T integrated and the control groups.

Levene's Test for Equality of Variances			t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	3.71	.06	-2.78	54	.007	-10.86	3.90	-18.68	-3.03
Equal variances not assumed			-2.78	48.95	.008	-10.86	3.90	-18.70	-3.01

From Table 8, the p-value of 0.007 is less than 0.05, that is, $p<0.05$, this shows that there is a statistically significant difference between the posttest scores of the experimental and control groups. The t-value of -2.78 certifies that the ICT-integrated method produced significantly better results than the common method of teaching.

V. Conclusion

Based on the results, the t-value of -3.434 and significant value of 0.001, for the pretest and posttest of the experimental group, it is concluded that there is an increase in the students' performance from the pretest to the posttest results. This increment is significant because the t-value of -3.434 lies outside the lower and upper t- values.

Also, from the posttest results of both the experimental and the control groups, the t-value of -2.782 supported by the significant value of 0.007 is an indication that, the I.C.T incorporated method of teaching yielded better results than the usual teaching methods. In all, the significant increment for the pretest and posttest mean scores for the experimental group shows that, the I.C.T integrated method is the one that produce better results in the teaching of the topic atomic structure. This approach is effective in fostering greater student engagement.

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VI. Recommendation

Based on the conclusions, it is recommend that chemistry tutors or teachers be encouraged to integrate information and communication technology (I.C.T) in teaching the atomic structure. The I.C.T skills can be transmitted to the teacher(s) by integrating it into the teacher training centers as one of the mandatory course to be offered by teacher trainees. This will enable them to be familiar and confident at using the I.C.T tools. This enable them to use the skill in teaching and this will facilitate more profound learning experiences and good understanding of the concepts in the topic among the students. Also, chemistry students should be challenged to use the internet and other technological mediums in their learning and doing of assignment especially in the topic, atomic structure.

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