Hands-on Learning Methods and Academic Performance in Chemistry at Ordinary Level in Kira Municipality, Uganda

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Abstract. *The primary focus of the study was to evaluate on hands on learning methods and students' academic performance in Chemistry at "O" Level in Kira Municipality, Wakiso district, Uganda. The research used a cross sectional survey design and employed both qualitative and quantitative approaches. A sample of 184 respondents was selected using purposive and snowball techniques. The findings indicated that collaborative learning was inadequately applied, which led to statistically significant negative relationship with academic performance in Chemistry examinations. Findings further revealed a weak positive relationship between demonstration and performance and a strong negative relationship between experimental projects and academic performance (because experimental projects were nearly non-existent in all the schools). The study concludes that inadequate application of collaborative learning, demonstration and experimental projects cripples students' ability to perform well in Chemistry. Therefore, it recommends that both teachers and students be provided with the avenues they need for hands-on teaching and learning of Chemistry.*

Key words: STEM, Curriculum innovation, SESEMAT.

Introduction

In 2008 the government of Uganda made a policy that Sciences at Uganda Certificate Education Level are compulsory for future economic development. Since then the government has equipped many schools with laboratory equipment and teachers, including mandatory Science and Mathematics (SESEMAT) programs. Chemistry cuts across all the sciences responsible for industrial development but since 2008 till today the Uganda certificate of education national examination results in Chemistry continue to show poor results. Therefore if the trend remains like that Uganda cannot achieve vision 40 and industrialization unless a study is done to find best modalities of learning Chemistry for the improvement in Uganda certificate of education national examination results. This calls a paradigm shift to focus on best learning methods of Chemistry for academic performance in Uganda certificate of education national examinations.

Problem

The ideal situation of learning Chemistry should be the practical way whereby students have to do and demonstrate practical skills for better

academic performance (National council of science and Technology 2012). The National Curriculum Development Centre and Ministry of Education and Sports support that teachers should use hands-on-learning methods such as collaborative, demonstration and experimental projects as methods of learning. However the situation at hand today is that teaching and learning Chemistry continues to register very high percentages of failure in Chemistry at National examinations therefore there must be a problem responsible for the poor performance (National council of science and Technology 2012). According to National council of science and Technology 2012 report statistics show that there have been a decline in core secondary school science performance and in this case we mean in Chemistry, physics, biology and mathematics. In 2005 -2008 respectively performance of physics was 70%,60%,40%41% and Chemistry same years respectively was 55%,55%,30% 26%, and biology similarly following same trend scored 59%,50%,61%,59% while mathematics following the same sequence scored 61%,77%,78%,80%.Of all core science subjects of secondary school the above figures show that Chemistry is the most poorly performed subject. If performance remains like this, schools may have a big challenge in producing practical scientists in Chemistry which affects national technological departments, national health systems, general welfare and industrialization.

Purpose of the Study

The purpose of the study was to evaluate how hands-on learning methods can influence students' academic performance in Chemistry at "O" Level.

Objectives of the Study

1. To find out the effect of collaborative learning on academic performance in Chemistry at "O" Level in Kira Wakiso district.
2. To establish the effect of demonstration on academic performance in Chemistry at "O" Level in Kira Wakiso district
3. To establish the effect of experimental projects on academic performance in Chemistry at "O" Level in Kira Wakiso district.

Scope of the Study

This research covered the different Hands-on methods of learning Chemistry as collaborative, demonstration, and experimental projects.

The study also looked at the effect of such methods on students' academic performance in Chemistry at Uganda certificate of education examinations. The study covered the period between 2011 and 2015 because these years have registered a decline in the performance of Chemistry at Uganda certificate of education. The study covered selected schools of Kira Municipality in Wakiso District, Uganda which is about 10 km from Kampala capital city on Kampala- Jinja road to the east. The area of Study is chosen because it has so many schools both private and government of different standards. Kira represents both rural and urban setting with government schools and non-Government schools. Kira has Universal Secondary Education (USE) and non-USE, with good academic performance and poor academic performance and it was also convenient for the researchers.

Conceptual Framework

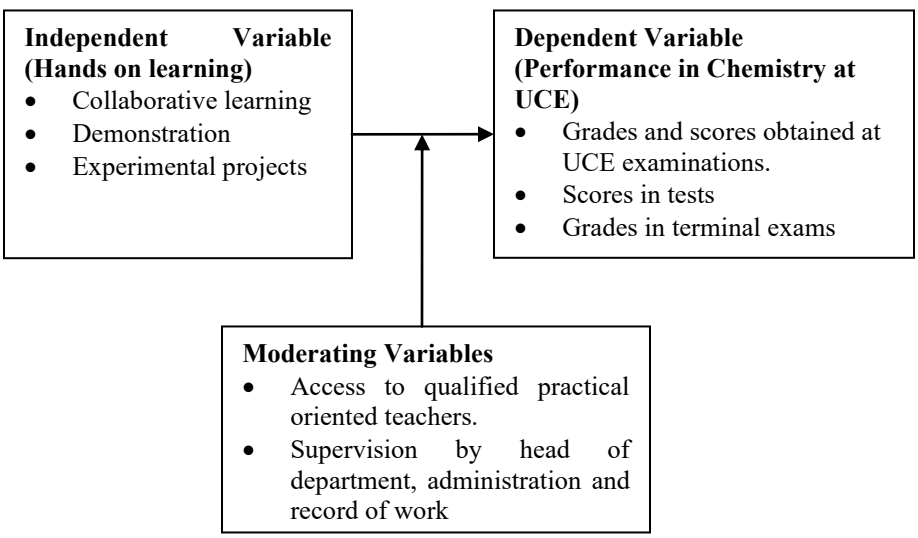

Figure 1: Model of the Conceptual Framework

Collaborative Learning and Students' Academic Performance in Chemistry

In spite of the central and important position of Chemistry among other sciences and related disciplines, academic performance of students in Chemistry at Senior Secondary School Certificate Examination (SSSCE) has consistently been very poor and unimpressive (Njoku, 2005). Many factors have been suggested as contributing to this poor performance of students in Chemistry in particular and science in general. Some of

these factors include: inadequate laboratory equipment in Chemistry (Eniayeju, 2010); poor teaching methods (Ayogu, 2001); poor training of teachers and mathematical nature of Chemistry among others.

The aspect of students' collaboration in balancing chemical equations has been recognized as one of the basic chemical issues in Chemistry, as suggested by Ababio, (2004). Anthony, 2009) reported that collaboration in, and the understanding of balancing chemical equation is a prerequisite to the comprehension of some learning tasks in Chemistry such as chemical equilibrium, electro Chemistry and organic Chemistry. Balancing chemical equations also is one of the difficult concepts Chemistry students encounter in both practical and theory. Similarly, WAEC(West African Examination Council) chief examiners' reports of 2009, 2010, and 2011, ascertained that, what made most Chemistry students perform poorly in Chemistry, was the inability of the students to write correctly, reactants, products as well as to balance the reaction equation correctly.

A number of activity oriented instructional strategies have been advocated for by curriculum designers and science educators (Eniayeju, 2001) in Dahiru (2013) to help improve on the failure rate among secondary school science students. Examples of these strategies include guided discovery approach, collaboration method, discussion method and problem - solving for teaching senior secondary school Chemistry as stipulated in National Policy on Education. Research findings had however, revealed that, a large proportion of science teachers, Chemistry inclusive, still resort to the use of traditional/lecture method rather than the activity –oriented or student centred strategies advocated for, such as participation method, problem - solving and others (Olorukooba, 2001).

Demonstration and Academic Performance in Chemistry

Scholars the world over have now recognized that there are better methods of learning than through the conventional ways of instruction (Achor et al., 2009). Secondary schools have realised the relevance of utilisation of appropriate methods such as demonstration through which students can learn (Ajiboye et al., 2008). Further, several methods of teaching have been proved to be relatively ineffective on students' ability to master and then retain important concepts.

Bello, (2011) noted that learning through some methods of teaching is passive rather than active. The applications of the traditional methods like lecture, memorizing, recitation, among others do not seem to aid critical and creative thinking, and collaborative problem-solving.

According to Colbum, (2005) in Uhumuavbi, and Mamudu (2009) the challenge in teaching is to create experiences that involve the students and support their own thinking explanations, evaluations, communications and applications of scientific models needed to make sense of these experiences. Daniel and Bimbola, (2010) indicated that science subjects are more affected in this trend of development. Chemistry, which is purely science based, is more of practically-oriented learning experiences than mere theories. For instance, in spite of the frantic efforts made by the government to enhance teaching of science/ Chemistry science syllabus, by employment of qualified graduate teachers, provision of facilities and prompt payment of salaries, among others, the recent students' results at external examinations show a decline in performance.

According to Adah (2011) the reason behind poor performance in Chemistry is that it is practical and skill oriented subject yet it is mainly taught theoretically in most cases. It is supposed to enable students acquire basic knowledge and practical skills compared to theory. However, there has been a general perception of science by an average student, that Chemistry is very difficult thus making it dominated by students deemed to have higher intellectual capacity thus de-motivating majority of the students.

Experimental Projects and Academic Performance in Chemistry

During scientific or experimental projects, the outcome can be predetermined or undetermined; the approach can be inductive (where the students observe particular instances to derive general principles, or deductive, where the students apply a general principle toward understanding a specific phenomenon (Lawal, 2009). The expository style (sometimes called verification) of laboratory instruction is the most popular because it can be performed simultaneously by a large number of students with minimal involvement from the instructor, at low cost, and within a 2-3 hour period of time, all factors that represent serious logistic constraints when large numbers of students are involved. Clearly the choice of experiments is based on convenience rather than pedagogy. Inquiry laboratories are inductive, have an undetermined outcome, and require that students generate their own procedures. Since the inquiry approach places more responsibility on the students, it's not surprising that student ownership over laboratory activities increases, which results in students showing improved attitudes toward science instruction and to improve their ability to utilize formal operational thought (Njoku, 2005).

According to Okebukola, (2005) properly executed, inquiry laboratory experiments require students to devise plans that invite intellectual and pedagogic methods and they engage higher order thinking skills— hypothesizing, explaining, criticizing, and analysing, judging evidence, inventing, and evaluating arguments. Okeke, (2002) contends that discovery learning through experimental projects is meant to personalize the information students acquire, making it more meaningful and, thus, better retained. In addition, Dahiru (2013) avers that a problem-based environment encourages students to apply their understanding of a concept to answer questions for which answers do not yet exist.

Methodology

The study used a cross sectional survey design with a sample size of 5 Head teachers purposively selected, 19 Chemistry teachers and 160 Chemistry students obtained by snowball sampling techniques. The sample size was calculated using Krejcie and Morgan 1970.

Data quality control measures was undertaken to ascertain the accuracy and consistence of the data collected. The data collection instruments were pretested to ensure validity and reliability. Validity was calculated using Content Validity index teat as seen in Table 1.

Table 1: Content Validity Indices

Variable	Content validity Index	Number of items
Collaborative learning	0.8181	11
Demonstration	0.7	10
Experimental projects	0.857	7
Academic performance	0.8	5

Reliability was determined using Cronbach's Alpha method. The co-efficient was established at .884, meaning that the instrument was consistent. Respondents according to different attributes showed that majority (55%) of the respondents were females while 45% were males. The highest number of respondents (85%) was between the age group 15-20 because most of them were Chemistry students.

Findings and Interpretation

On collaborative learning and academic performance in Chemistry, it was established that most school laboratories did not have enough equipment for practical lessons as revealed by 64.4% of the respondents compared to only 25.7% while 10% were not sure. The corresponding

mean for this finding was 2.37 which is below average while the standard deviation was 1.330, an indication that most respondents revealed that laboratories do not have enough equipment for Chemistry practical lessons. This was further supported by one of the Head teachers during face to face interviews who said:

> "Our school has no laboratory but just small laboratory stores. The school does not have sufficient laboratory equipment". In addition, the school lacks chemicals and chemical reagents while other chemicals are expired, and the apparatuses are out of use."

The above finding was compounded by the fact that the school Chemistry was unable to name all the laboratory equipment available in their school.

Similarly, the study further revealed that students do not have access to enough chemicals for practical lessons as confirmed by 53.1% of the respondents who disagreed against 35.6% who agreed. On the other hand, 11.3% were not sure. The obtained mean was 2.67 while the standard deviation was 1.315, which shows that most respondents disagreed.

On whether schools have enough infrastructures for Chemistry practical lessons 70.6% of the respondents disagreed, 17.5 agreed while 11.9% were not sure. The obtained mean was 2.15 and the standard deviation 1.209. This was supported by one of the school head teachers who had this to say;

> "Our school has no laboratory but we have a laboratory store where we keep some laboratory apparatus and chemicals"

This shows that the school lacks enough infrastructures to support students in Chemistry practical lessons. This further explains why students are able to correctly write reactants as reported by 36.9 % of the respondents who disagreed, though 30.6% agreed while 32.5% were not sure. The obtained mean was 2.82 which is less than 3.0 while the standard deviation was 1.159. This shows that most schools do not have enough infrastructures, which explains why academic performance in Chemistry at UCE exams is poor.

Study findings further revealed that teachers use activity oriented methods while teaching as revealed by 68.2% of the respondents who agreed while 18.8% disagreed and 13.1% were not sure. The corresponding mean of 3.67 which is above average shows that majority of the respondents agreed while the standard deviation was 1.221 an indication that few respondents gave varying responses. However, results from face to face interviews revealed that sometimes, activity

oriented methods are not used as reported by one of the Head teachers who had this to say;

> "The methods used for teaching Chemistry at this is school is that the teacher gives notes to student leaders to dictate to fellow students and the teachers comes later to explain those notes to students. In addition, chalk and talk method of teaching is also used."

This shows that students are not much engaged in activity oriented lessons which retards their ability to comprehend practical activities. Asked whether collaborative learning is used to study Chemistry at school, 56.9% of the respondents agreed while 29.4% disagreed and while 13.8% were not sure. The corresponding mean for the statement was 3.36 while the standard deviation was 1.353. This shows that most collaborative learning is used by most teachers while teaching Chemistry.

Relatedly, study findings further revealed that students are given set plans and objectives before learning tasks as reported by 53.8% of the respondents compared to 37.5% who disagreed while 8.8% were not sure. The obtained mean was 3.22 while the standard deviation was 1.453. This shows that majority of the respondents agreed with the statement. When students are given set plans and objectives before learning tasks, they are able to follow the required procedures which contribute to improved academic performance.

Regarding whether students work together to accomplish tasks and monitor progress, majority 58.7% of the respondents agreed though 30.6% disagreed while 10.6% were not sure. The corresponding mean of 3.36 and the standard deviation of 1.393 show that most respondents confirmed the statement. This means that efforts are made to ensure that students work together to accomplish tasks which provides them with a plat form to learn from each other, thereby leading to improved academic performance.

However, when asked whether students often have a test anxiety for examinations 41.3% of the respondents agreed, 45.1% disagreed, while 13.8% were not sure. The obtained mean was 2.92 which is below average and the standard deviation, 1.521. This shows that most students often have a test anxiety for examinations which has a negative effect on their academic performance in Chemistry at UCE examinations. This was confirmed by one of the deputy head teachers during interviews, who had this to say;

> "Students panic too much during exams, and this affects their academic performance."

During the study, if was found that students have enough lessons of Chemistry per week as revealed by 58.8% of the respondents who agreed compared to 36.3% who disagreed, while only 5.0% were not sure. The obtained mean was 3.37 and the standard deviation, 1.557. This shows that most respondents agreed that they have enough Chemistry lessons per week. On the contrary, the study revealed that students do not have enough practical lessons per week as revealed by 52.5% of the respondents who disagreed compared to 41.9% who agreed and 5.6% that were not sure. The obtained mean was 2.72 while the standard deviation was 1.557 which shows that majority of the respondents disagreed. This was further confirmed by one of the Head teachers who revealed said;

> "Practical lesson is conducted once a term. Directors do not purchase chemical and apparatus required because they are expensive. In addition, practical lessons are done rarely and after a long period having already done the related theory."

This means that students do not have enough exposure to practical lessons which affects their academic performance at UCE exams.

On Demonstration and academic performance in Chemistry results indicated that students learn by doing things and telling (reporting) how to do them. This is seen when 58.1% of the respondents agreed while only 26.9% disagreed and 15.0% were not sure. The obtained mean was 3.44 while the standard deviation was 1.386. This implies that if students learn by doing things and telling how to do them, they are likely to perform better in Chemistry at UCE examinations.

When asked whether students are allowed to carry out class activities in group (group interactions), 86.3% agreed, and 12.5% disagreed, while 1.3% was not sure. The corresponding mean was 4.06 while the standard deviation was 1.201. This shows that majority of the respondents agreed with the statement. The above findings were supported by one of the teachers when he said;

> "Students are normally encouraged to carry out class activities in groups in order for them to discuss and learn from each other. When students are involved in group interactions, they understand things they were unable to grasp while in class."

The above finds were supported by 61.9% of the respondents who revealed that the method of teaching Chemistry at school is activity oriented. Only 24.4% disagreed while 13.8% were not sure. The obtained mean was 3.48 while the standard deviation obtained was 1.373. This indicates that majority of the respondents concurred with the statement.

This further implies that engaging students in classroom activities contributes to their better understanding of what they have been taught, leading to improved academic performance.

Findings in the table above further revealed that students study Chemistry using conducive methods as reported by 48.1% who agreed, compared to 35.7% of the respondents that disagreed. On the other hand, 16.3% were not sure and the obtained mean was 3.13 while the standard deviation was 1.365. Some of the methods used include chalk and talk method, while other times, teachers give notes to students, they copy them and the teacher explains later.

On whether students are given work, marked and discussed, majority 65% agreed, 31.3% disagreed, while 3.8% were not sure. The mean was 3.43 and the standard deviation was 1.532. This implies that students are regularly tested after which discussions are held to enable students understand areas they found difficult for them. The study further revealed that majority (49.4%) of the students understand the use apparatus though 23.8% disagreed while 26.9% were not sure. The corresponding mean was 3.34 and the standard deviation was 1.264. On the contrary, interviews with one of the Deputy Head teachers revealed that students have limited exposure to apparatus when she said;

> "The school does not have enough equipment/ apparatus to use in Chemistry practical lessons. This affects the students' ability to use the apparatuses, thereby performing poorly during UCE examinations."

The above revelation implies that some schools do not have enough apparatuses, which limits students' chances and ability to use them, thereby performing poorly in Chemistry exams.

Relatedly, findings in table 6 indicate that students do not understand measuring of reagents and solutions as revealed by 40% of the respondents who disagreed compared to 32.5% who agreed and 27.5% that were not sure. This is further supported by the corresponding mean of 2.77 and the standard deviation of this implies that if students do not know how to measure solutions, they are likely to fail Chemistry practical exams. On whether the school has enough demonstration equipment, 59.4 disagreed, 26.9 agreed while 13.8% were not sure. The corresponding mean was 2.44 and the standard deviation was 1.335. This implies that most schools do not have enough demonstration equipment. This was confirmed during face to face interviews, when one of the respondents had this to say:

> "The school does not have enough demonstration equipment, and because of this, demonstration is used on few occasions depending on the topic being studied."

The study tried to establish whether schools have running water in the laboratory. To this, only 32.5% of the respondents agreed, while majority 61.9% disagreed and 5.6% were not sure. This was confirmed with the mean value of 2.43 while the standard deviation was 1.620. In the same way, 64.4% of the respondents reported that schools do not have laboratory taps proper for rubber tubing 64.4%. Only 26.3% agreed while 14.4% were not sure. The corresponding mean was 2.23 while the standard deviation was 1.485. This implies that most school laboratories do not have running water, which affects effectiveness in conducting practical lessons in Chemistry.

Concerning Experimental projects and academic performance in Chemistry results revealed that 36.2% of the respondents revealed that students use expository or verification style while learning Chemistry. On the other hand, another 36.3% of the respondents disagreed while 27.5% were not sure. The obtained mean was 2.82 while the standard deviation was 1.252. This implies that expository or verification style is not used by most students. This was supported by one of the Head teachers who reported;

> "Verification style is used very few (for instance twice) throughout the four years and sometimes they combine S.3 & S.4 in the laboratory store. In addition, the room is too small therefore some students end up being spectators."

The above revelation indicates that students are not regularly exposed to Chemistry practical lessons, and are unable to verify what they are taught in class which retards their academic performance.

The choice of experiments to use is based on convenience 43.2% disagreed, 30% agreed while 26.9% were not sure. The obtained mean was 2.70 while the standard deviation was 1.191. When asked whether students often engage higher order thinking skills such as hypothesizing, analysing and judging evidence, 37.5% of the respondents agreed, 35.6% disagreed while 26.9% were not sure. The corresponding mean was 2.91 and the standard deviation was 1.336. This shows that most students are not often engaged in higher order thinking skills and this limits their ability to comprehend practical Chemistry elements.

On whether students use discovery learning through experimental projects, 52.6% agreed while 32.5% disagreed and 15.0% were not sure. The mean value of 3.14 and the standard deviation 1.362 indicates that majority of the respondents confirmed that students use discovery learning through experimental projects. Similarly, 49.4% of the

respondents agreed teachers use problem solving-based environment while teaching. On the other hand, 31.9% disagreed while 18.8% were not sure. The obtained mean was 3.21 while the standard deviation was 1.318. This indicates that teachers use problem solving-based environment to ensure that students are able to properly comprehend what they are taught which may contribute to improved academic performance.

When asked whether teachers use laboratory experimental instructions as a method of learning, majority 71.9% agreed while 21.9% disagreed and 6.3% were not sure. The corresponding mean was 3.68 while the standard deviation was 1.402 which shows that most teachers use laboratory experimental instructions.

Recommendations

The study recommends that both teachers and students be provided all avenues to involve their hand on in the teaching and learning of Chemistry which requires laboratories, equipment and chemicals for students' group discussions and assignments. Teachers should give plans of practical sessions to students and laboratory technicians early enough to know and prepare. Schools should also hire more trained laboratory technicians who are fulltime staff, and at least one fulltime teacher for practical lessons.

Demonstrations show the relevance of Chemistry to daily life and they should be carried out to encourage students have a positive attitude towards Chemistry. Teachers should also avoid demoralizing students, and not tell them that Chemistry is a hard subject but rather allocate them more time to demonstrate Chemistry practical lessons. Academically weak students should be allocated teachers to mentor and demonstrate to practical lessons to improved academic performance. Teachers should be trained on how to incorporate practical aspects within a theory lesson of Chemistry and this can be done through practical oriented workshops and by attending with concentration on the SESEMAT programs. Schools should establish laboratories and equip them with running water and proper drainage. Students should be encouraged to regularly access the laboratory in the presence of the laboratory technician. Principles of SESMAT and Cyber schools program and its training should be applied by all schools. Students should have some practical demonstrated within a theory lesson.

Teachers are advised to give regular work/assignments to students, mark it and discuss it with students. Refresher courses and seminars are recommended to be organized for both teachers and students on a

regular basis because a lot is covered, more interest in Chemistry is raised up, better use of laboratory and chemicals and attitude changes for better. Chemistry is a practical subject therefore it cannot be handled independent of student centred practical pedagogical approaches. Laboratory experimental instructions should be issued to students on at least twice a week to promote learning manipulative skills, understanding the use of apparatus, Fostering an understanding of scientific inquiry which includes: designing experiments, executing experiments, generating data, data analysis, interpreting data, developing: attitudes toward science, motivation, control of science, a sense of success, providing introductions of concrete examples to abstract concepts.

References

Ababio, O. Y. (2004). New School Chemistry for Senior Secondary Schools. Africans First Publisher's Limited Book House trust, 1, Nigeria.

Achor, E. E.; Imoko, B. I. and Uloko, E. S. (2009). Effect of ethno mathematics teaching approach on senior secondary students' achievement and retention in locus. Education Research and Review. 4(8): 385-390

Adah, O. C. (2011). An assessment of students' perception of agricultural science as a course of study in secondary schools in Kogi State. Journal of Vocational and Technical Educators, 2(1), 14-19.

Ajiboye, J. O. and Ajitoni, S. O. (2008). Effect of full and quasi-participatory learning strategies on Nigerian senior secondary students' environmental knowledge: Implication for classroom practice. International Journal of Environmental and Science Education. 3(2): 58-66

Amin, E. M. (2005). Social science research: Conception, methodology and analysis. Makerere University Printery, Kampala: Uganda.

Anthony, A. D. (2009). The Effect of Simulation Games on Senior Secondary School Students' Performance and Attitude towards Balancing of Chemical Equations. An MPHIL Dissertation presented to the Dept. of Science Education, Winneba Ghana.

Ayogu, Z. U. (2001). Enriching Science, Technical and Mathematics Education. 41st National Conference Proceedings of the Science Teachers Association of Nigeria. 396 - 399.

Colbum, M. (2005). In: Uhumuavbi, P. O. and Mamudu, J. M., 2009. Relative effects of programmed instruction and demonstration

methods on students' academic performance in science. College Student Journal. 1-13

Daniel, O. I. and Bimbola, O. (2010). Effect of constructivist-based teaching strategy on academic performance of students in integrated science at junior secondary school level.

Dahiru S. Y. (2013) Effects of using gagne's learning hierarchy on chemistry students' academic achievement and anxiety level in balancing chemical equations in secondary schools in Katsina metropolis, Nigeria

Eniayeju, D. (2010). Competencies Required of Science Education Teachers. A paper presented at the 24th Annual Conference of the Science Teachers Association of Nigeria

Lawal, F. K. (2009). Effectiveness of a Conceptual Change in Situation Strategy in Remediating identified misconception in Genetics among Senior Secondary School Students in Kano State. Unpublished PhD dissertation presented to the Department of Education, A.B.U. Zaria.

Krejcie, R.V., & Morgan, D.W. (1970).Determining sample size for research Activities, Educational and psychological measurement: Sage Publications

Kothari, C.R. (2008) Research Methodology, 2nd ed., New Age International Publication, New Delhi, India.

Njoku, Z. C. (2005). Level of Chemistry Practical Science Skills Acquired by Senior Secondary School (SSII) Students. Nigeria Journal of Professionals Teachers, 2(2).

Okebukola, P. A. O. (1997). The state of science education in Nigeria. Paper presented at the ELLSA-British Council Primary Science Forum, Kaduna, Nigeria.

Olorukooba, S. B. (2001) The Relative Effects of Cooperative Instructional Strategy and Traditional Methods on the performance of Senior Secondary School Chemistry Students. An unpublished PhD Dissertations A.B.U Zaria.

Okeke, E. A. (2002).Attracting Women into Science Technology and Mathematics Education.

Uhumuavbi, P. O., Mamudu, J. M. (2009). Relative effects of programmed instruction and demonstration methods on students' academic performance in science. College Student Journal. 1-13