

Mathematics Skills as Predictor of Chemistry Students' Performance in Senior Secondary Schools in Akoko - South Local Government Area of Ondo State, Nigeria.

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Abstract

The purpose of this study is to investigate the predictive effects of mathematics skills on students' performance in chemistry. The study adopted the pre-test and post-test control group quasi-experimental design. A sample of 136 students were randomly selected from two Senior Secondary Schools (SSS2) in Akoko - South Local Government Area of Ondo State. One research question and one null hypothesis were used for the study. A Chemistry Achievement Test (CAT) which involved the use of mathematics skills was used and administered. The data collected were analysed using mean, standard deviation, percentage mean, t-Test, and One way ANOVA statistics at 0.05 level of significance. The result revealed that significant difference existed between the scores of students exposed to experimental group and that of their counterpart in the control group. One of the recommendations is that the use of collaborative teaching among the mathematics and chemistry teachers in secondary schools should be emphasised by the curriculum planners and the government. This will reduce the under achievement problem in chemistry among the secondary school students.

Key words: Predictor, Students Performance, Chemistry, Mathematics skills

1.1 Introduction

Mathematics is an essential and integral component of all the scientific discipline. It has been the bedrock of several subjects in the secondary school curriculum. Chemistry is one of the science subjects taught at the senior secondary level of educational systems in Nigeria. The place and role of this subject as discipline cannot be over-emphasized, especially in the area of science and technology. Students with an objective of attaining a high level in the knowledge of scientific concepts must possess some basic knowledge in mathematical concepts and principles.

Mathematics, Physics and Chemistry are indispensable science subjects at the senior secondary school level in Nigeria. This is so, because no student can study any course in Agricultural Science, Medicine, Engineering and Pure Sciences without a good knowledge and grade in Mathematics, Physics and Chemistry at the Senior Secondary School Certificate (SSCE) level. This is exemplified by the adequate

attention paid to the teaching and learning of Mathematics, Physics and Chemistry in the 6-3-3-4 educational system launched on 8th September, 1982 by the Federal Government (Federal Republic of Nigeria, 2014). In this scientific age, mathematics as a discipline allows student to understand and solve some important problems in chemistry in terms of concepts and principles. For examples, the knowledge acquired in the learning of the concepts like fractions, ratios and proportion, percentages, function of integration and differentiation in mathematics could be used to solve numeric problems like the mixing and dilutions of solutions, mole concept, stoichiometry reactions, acid-base reactions, and gas laws in chemistry. Besides, the understanding of indices and logarithm in mathematics could be applied to understand the learning of the concept of pH scale, rate of reactions in Chemistry.

Many researchers and chemistry educators have expressed the opinion that mathematics is one of the problems militating against students' progress in chemistry (Offiah and Samuel, 2008; Akpan and Okoro, 2012; Oyedeji, 2011; Awodun and Ojo, 2013; Allan and Rory, 2014). This shows that the learning of chemistry requires numbers of mathematical concepts and principles for easy understanding and comprehension. Offiah and Samuel (2008) covered three topics in Chemistry (Electrolysis, Energy and Chemical Reactions and Gas laws) to selected three hundred (300) SSS2 students from six secondary schools in Akwa Education Zone comprising of three (3) intact groups of fifty (50) students. Each was given 3 different treatments. The first three were taught some mathematical topics, the second group, were taught the mathematical topics during chemistry lessons, while those in the third group were not taught the mathematical topics at all. The summary of their findings revealed that chemistry students who were taught mathematical principles prior to chemistry lessons performed better than those who received both mathematics principles and chemistry lessons simultaneously and those who were taught only chemistry. The mathematics topics taught were significant figures, simple equations, statistics for treatment of data, change of subject of formula and mensuration. Barnes (1978) studied mathematics skills for chemistry as a predictor of success in beginning college chemistry for science majors. Research finding indicated that Mathematics Skills Test (MAST) had the highest Pearson (r) with the chemistry final grade. Three regression equations were selected from the results of the multiple stepwise regression analysis to be most effective predictors of success. Wang and Santos (2005) carried out a 'comparative study of relationship between mathematics and science achievement at the 8th Grade. They found out that there was a correlation between the achievement in mathematics and science. Helfgoft (2006) noted that some concept in mathematics have divert relationship with thermodynamics and chemical kinetics. For example, the knowledge gained in differentiations, integration and exponential function could be used to solve numerical problems in finding the relationship between the rates of reaction 'R' at the temperature 'T' of any given gaseous substances.

Sadler and Tai (2007) in their influential US study showed the importance of learning mathematics in high school for subsequent learning in university science. They established that study in mathematics and the relevant science specialist subject as the most influential prior learning for attainment in Biology, Chemistry and Physics in Universities and Colleges across the United States (US). Chibuogwu and Mars (2006) presented a table showing the proportion of students' enrolment in science, technology and mathematics STM subjects in the SSCE WAEC May/June 2004. The entries indicated 832, 689 candidates

for Mathematics which is a compulsory STM subjects for all Nigeria candidates while a total of 269,774 candidates enrolled for Chemistry which represented a mere 32.4 percent of the total candidates. The implication of this is that out of out of the 32.4 percent enrolled for chemistry only 39 percent of these students passed chemistry at credit level and above as shown formerly by the researchers which is a mere 105,211 candidates.

According to Koleoso (1983), the quantitative relationship as well as the theoretical foundation of sciences especially of chemistry and physics, rest largely on mathematics. In the learning and teaching of chemistry, the understanding of the subject depend largely on students' ability to use mathematical concepts to solve quantitative problems in chemistry. In order to motivate students to have interest in chemistry subjects, Adeyegbe (2000) suggested the use of collaboration among mathematics and chemistry teachers in schools should be emphasized by the government. This is necessary to ensure that mathematics pre-requisites knowledge for problem-solving in chemistry are mastered by students.

Results from the Third International Mathematics and Science Study (TIMSS) placed United States high school students' literacy in the lower third of countries included in the Final Year of Secondary School (Mullis, Martins, Beaton, Gonzalez, Kelly & Smith, 1998). The subsequent uproar in response to these results has been further fueled by more recent findings from American College Testing (ACT, 2003), suggesting that, although standardized test scores have risen in the past few years, mathematics and science preparation in high school appears to be weak. As a result, many high school students founder when they undertake college studies. However, many other students do find great success in college science courses. The identification of factors that relate to science success or failure of students may provide useful clues for promoting science learning and achievement. Previous research suggests that influential factors fall within three categories.

Studies connecting high school chemistry with college chemistry have been published in long-running journals such as school science and mathematics and the journal of chemical education since the 1920s (Brasted, 1957, Everhart and Ebaugh, 1925). They reviewed 24 studies published and concluded the following:

There are some indications that the taking of high school mathematics may be used as an indicator of success in college chemistry. There are indications that a math/physics background, high placement scores, achievement tests scores, intelligence and age may be a better, or at least as good as indicators. There is also evidence that no indicator is all that good. (p.125)

1.2 Statement of the Problem

Students in science education especially in chemistry programme in Nigeria are always required to do mathematics in their respective courses. Experience has shown that some students run away from the chemistry courses because of their under achievement in mathematics. However, despite the student's attitude in the above regards, admission requirement into chemistry programme still demand credit grade at the higher school of learning in Nigeria. Is proficiency in mathematics a sine-qua-non for a thorough understanding of chemistry as being asserted by some teachers and students? The likely questions to be

asked are: Why are chemistry students required to do mathematics? Is there a relationship between chemistry and mathematics as subject? Can success in mathematics could be used to predict success in chemistry? Therefore, it is imperative to determine to what extent a good performance in mathematics would be a good predictor of students' performance in chemistry.

2.1 Methodology

The study adopted the pre-test and post-test control group quasi-experimental design. The population of the study was all the public Senior Secondary School II chemistry students in Akoko South Local Government Area of Ondo State. One hundred and thirty six Senior Secondary School class II chemistry students were selected from two schools. Before the commencement of the experimental group, the scheme of work of the affected subjects were rearrange among the chemistry and mathematics teachers. That is, the concepts like fractions, ratios and proportion, percentage, indices and logarithm in mathematics was taught in the same weeks with the concepts of mole, stoichiometry reactions, PH scale, mixing and dilutions of solutions in chemistry. The Chemistry Achievement Text (CAT) consisted of 40 items based on the applications of some mathematics principles. The instrument was given to the test expert who critically assessed it for content validity and ensured that all the test items were relevant to the learning activities in the curriculum of Senior Secondary II programme. The reliability of the instrument was tested using Kuder Richardson Formula (k_{20}) and reliability coefficient of 0.74 was obtained. The data collected were analyzed using mean, standard deviation, percentage mean and t-Test statistics at 0.05 level of significance.

2.1 Research Question: Does mathematics skills influence the students' performance in chemistry?

2.1.1 Research Hypothesis: There is no significant difference in the academic performance of chemistry students who were exposed to mathematics skills during the chemistry lesson and those who did not.

3.1 Results and Discussion

Research Question: Does mathematics skills influence the students' performance in chemistry?

Table I: Comparison of pre-test, post-test and percentage mean scores of students' performance in chemistry

Group	N	Pre-test mean score	Percentage mean score	Post-test mean score	Percentage mean score
Experimental group	68	26.16	50.35	57.50	61.18
Control group	68	25.79	49.64	46.49	49.46

Source: Field work, February, 2018.

In table I, the mean scores and percentage mean score for the pre-test of both experimental and control groups are 26.16, 25.79 and 50.35, 49.64 respectively. This shows that the percentage mean score of the experimental and control groups were low at the start of the study. This indicates that both groups were almost homogenous at the point of commencement. In other words, the background knowledge of these

students' in the two groups were relatively equal and low. At the post-test stage, the mean scores and the percentage mean scores of both groups are 57.50, 46.49 and 61.18, 49.46 respectively. This shows that there is improvement of the students' performance from the pre-test to post-test stage. However, the quasi-experimental group performed better than the control group as a result of the exposure of students to some skills and principles in mathematics during the chemistry lesson.

3.1.1 Research Hypothesis: There is no significant difference in the academic performance of chemistry students who were exposed to mathematics skills during the chemistry lesson and those who did not.

Table 2: t-Test summary of the students' academic performance of both experimental and control groups

Variables	N	Mean	SD	Df	C value	T value
Experimental	68	57.50	11.41	134	6.34	1.96
Control	68	46.49	8.68			

Source: Field work, February, 2018.

$P > 0.05$ significant at $p = 0.05$

Decision – H_0 is rejected.

Table 2 shows that the degree of freedom was found to be 134, the table value was found to be 1.96 at 0.05 level of significance, while the calculated value was 6.34. This indicates that the calculated value is greater than the table value. This implies that significant difference existed between the scores of students exposed to experimental group and that of their counterpart in the control group. This result could be attributed to the treatment given to the experimental group. Thus, this hypothesis was rejected.

Table 3: Shows one way ANOVA of Students' Performance Chemistry.

Posttest

	Sum of Squares	Df	Mean Square	F_{cal}	Sig.	Decision
Between Groups	4125.007	1	4125.007	40.142	.000	rejected
Within Groups	13769.985	134	102.761			
Total	17894.993	135				

Source: Field work, February, 2018.

The p-value are compared with at the degree of freedom (0.05) between groups (1) and within groups (134). Table 3 shows that p-value was greater than the F_{cal} value. The null hypothesis was rejected. Hence, there was a significant different between the experimental and control groups

4. Discussion

The findings of the study revealed that performance of students was greater in quasi-experimental group than those in the control group. The fact that comparison between the post-test scores of the quasi-experimental group and those in the post-test in the control group revealed a significant difference. This is an indication that the exposure of students to some mathematics skills actually improved the performance of students in Chemistry. In this study, the introduction of some mathematics skills during chemistry lesson have been reported in the previous studies (Helfgoft, 2006; Awodun and Ojo, 2013; Oyedeji, 2011; Allan and Rory, 2014).

This observation implies that the teaching of mathematics skills during chemistry lesson have tremendous impact on the behavioural change of students towards the learning of chemical concepts. This finding corresponds with that of Offiah and Samuel, (2008) who found that chemistry students who were taught mathematics concepts and principles performed significantly better than the control group in cognitive learning tasks.

5. Conclusion

The study focus on the effects of teaching some mathematics principles that are relevant to the teaching of chemistry during lessons. It was observed that when these principles were present alongside with the teaching of Chemistry, it facilitates students' independent study as well enhance effective instruction during the Chemistry lesson; and this could reduce the achievement problem in Chemistry. It can be concluded that the introduction of some mathematics principles during chemistry lesson has positive impact on students' self-confident and goal directed behaviour which consequently helped them to learn effectively. Therefore, the results of this study shows that skills development in mathematics proved potent at predicting students' performance in chemistry. It can be said that students who do well in mathematics are expected to perform better in chemistry class.

6. Recommendations

Based on the result of the findings, the following recommendations were made.

- Adequate mathematics education programme should be given to the prospective chemistry teachers.
- In order to generate students' interest in chemistry as subject, the use of collaborative teaching among the mathematics and chemistry teachers in schools should be emphasised.
- There should be collaboration between mathematics and chemistry curricula.
- The government should invest more into mathematics and chemistry education since chemistry is the bedrock of technology and without technology a country cannot said to have advanced or developed.

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