

Achievement in Mathematics as a Correlate of Achievement in Sciences in Secondary Schools in Makurdi Local Government Area of Benue State, Nigeria

¹Kurumeh M. S., ²Igyu C. O. and ³Mohammed A.S.

¹Mathematics Education Unit, Department of Curriculum and Teaching,
Benue State University, Makurdi, Nigeria

²Federal Government College, Otobi - Benue State, Nigeria.

³Kwara State University, Molete, Kwara State, Nigeria.

Abstract

This study investigated the correlation that existed between mathematics achievement and the achievement in each of chemistry, physics and biology in WASSCE. The study is important because it re-emphasises the importance of mathematics to science and that mathematics achievement can be used to predict the achievement of students in science. The ex post facto research design was employed in carrying out the study. This involved the use of already existing data on the achievement of 480 students in six secondary schools in Makurdi local government area of Benue state. To this end, three research questions and corresponding three hypotheses were formulated to guide the study. Using Pearson product moment correlation and t-test statistics, it was found that there existed a significant relationship between mathematics and each one of chemistry, physics and biology at 0.05 level of significance. The study therefore recommended that the necessity of mathematics for science students in secondary schools be sustained and curriculum planners are to further incorporate contents in the four subjects involved in the study.

Keywords: mathematics, science, correlation, achievement, secondary schools, WASSCE, significant relationship.

INTRODUCTION

Mathematics as a subject as well as a field of study is seen as the language of science. This is credited to Galileo Galilei a 16th century mathematics scholar. It means different things to different people. It is the subject which describes the relationship that exists between numbers and other measurable quantities (Encarta, 2006). The importance of mathematics to science requires that mathematics be regarded as basic to the teaching and learning of science (Eraikhuemen and Oteza, 2008; Olayemi, 2009). Science and technology are two aspects of knowledge that combine to form the heart of national development. The view that the importance of Mathematics to science requires that it should be regarded as a basic to the teaching of and learning of science, vis-à-vis Biology, Chemistry and Physics is increasingly becoming popular to educators.

Chemistry is one of the science subjects that require a substantial mathematical base for its understanding. Problem solving is a part and parcel of Chemistry at the secondary school level. In Physics, quantum physics, thermal dynamics and statics, electric field, wave motion and sound are examples of areas where mathematics knowledge proves an invaluable tool. A credit level pass in the Senior Secondary School Certificate Examination (SSCE) is required for

admission into science and technology based courses in the various universities of learning (Ekpo and Usoro, 2011; Olayemi, 2009; Odili and Maduabum, 2007)

Manapure (2011) posits that a student needs basic knowledge of mathematics like change of subject of formula to understand density which appears under major topics like ecology in biology, diffusion in chemistry and floatation in physics. Vector quantity which is taught in physics requires a great deal of mathematics. Consequently relationships between variables such as volumes, pressure, temperature, are revealed through the use of mathematical concepts. Different mathematical topics such as vectors, calculus, logarithms and arithmetic are applied to solve scientific problems (Onwuka, Onwuka and Iweka, 2010). Many topics in the science subjects (biology, chemistry and physics) are inter-related. There are overlaps or areas of intersection in the content areas like the atomic structure. Fermentation is taught both in biology and chemistry.

STATEMENT OF THE PROBLEM

Biology, Chemistry and Physics require mathematics knowledge. It is also logical to think that there exists a marked educational gain in offering mathematics while offering the science subjects already

mentioned. The usefulness of mathematics demands that it be demonstrated as: "The gate and key of the sciences...Neglect of mathematics works injury to all knowledge" (Roger Bacon as quoted in Sidhu, 2006). There are branches/aspects of mathematics that go appreciated by only a few; so it may be in place to think that mathematics is in a greater danger of going into irrelevances than the other sciences (D'Ambrosio, 2003). In Nigeria however, mathematics has been made core and compulsory, especially for the sciences in gaining admission into tertiary institutions of learning. This has not gone down well with some stakeholders, especially students and parents/guardians who sometimes simply state that they "don't like mathematics" or "mathematics is too abstract" thereby questioning its usefulness. Thus the thrust of this research is: what is the relationship in the achievement of students in mathematics and science at WASSCE?

PURPOSE OF THE STUDY

This study aims at finding out if achievement in mathematics correlates with achievement in science in the West African Senior Secondary School Certificate Examination (WASSCE).

Specifically, the study examined:

1. The relationship that exists between mathematics achievement and achievement in physics at WASSCE.
2. The relationship that exists between mathematics achievement and achievement in chemistry at WASSCE.
3. The relationship that exists between mathematics achievement and achievement in biology at WASSCE.

SIGNIFICANCE OF THE STUDY

The significance of this study is to further strengthen the fact that mathematics knowledge is necessary to science achievement. Hence its justification as a core and compulsory subject as is already embedded in the National Policy on Education (NPE, 2004). For the policy makers; it is meant to justify or elucidate mathematics as pre-requisite for science related courses in tertiary institutions of learning. The study provides necessary information to the effect that mathematics achievement could be used to predict a corresponding performance in the sciences. Perhaps in the future it might be necessary for waver remarks for entry into the physical sciences (physics/chemistry) and the biological sciences with regards to which a credit pass in mathematics will be deemed mandatory.

THEORETICAL FRAMEWORK

Transfer of learning is the study of dependency of human conduct, learning, or performance on prior experience. The notion was originally introduced as transfer practice by Edward Thorndike and Robert S. Woodworth. They explored how individuals would

transfer in one context to another context that shared similar characteristics or more formally, how improvement in one mental function could influence another related one. Their theory implied that transfer of learning depends on the proportion to which the learning task and the transfer task are similar, or where "identical elements are concerned in the influencing and influenced function", now known as the identical element theory. Thus knowledge of skills and procedure in mathematics should help in the academic attainment of students in the branches of science already mentioned. Encarta (2009) posits that Gestalt psychology is a school of psychology that deals mainly with the processes of perception. According to Gestalt psychology, images are perceived as a pattern or a whole rather than merely as a sum of distinct component parts. Two activities found operating in this type of learning are generalization and differentiation. With generalization the learner makes ordered sense of facts, principles, feelings and attitudes which he is experiencing or had experienced through large amounts of positive transfer from one problem to another. These are guided by agent, goal and intervening conditions/obstacles (Gandhi, 2010).

METHODS AND MATERIALS

This study employed the correlational design in the ex post facto sense because its nature does not warrant a control and manipulation of variables (Emaikwu, 2010). Rather it involved the inspection, collection and analysis of data that had already occurred which was made available to the researchers in the form of students' achievement scores in the WASSCE in selected secondary schools. Six schools out of the 54 SSCE approved secondary schools in Makurdi local government area of Benue state, Nigeria were sampled. The area which is the center of learning and supervision academic programmes in the state was used to give credence to the research. The sampling is multi-staged, in that the six schools are purposefully selected for the study while bearing in mind the nature of each school. This is done in this manner in order to vary the types of school to cover single, mixed, and science oriented.

A total of 480 students were sampled by means of proportional sampling from each of the schools, that is, the more the number of students, the more the sample. This makes up 60 boys and 60 girls, that is, 120 students from each of the years from 2007-2010. In mixed schools however, the researchers ensured gender balance by sampling the same number of male and female students depending on the number of students in such a school.

DATA ANALYSIS AND RESULTS

Table 1: T-test for correlation between mathematics, chemistry and biology for the years 2007, 2008, 2009 and 2010

Year	Pair	N	Corr.(r)	t-calc.	df	t-critical
2007	Maths/Chem	120	0.966	40.59	118	1.98
	Maths/Phy	120	0.961	37.75	118	1.98
	Maths/Bio	120	0.880	20.13	118	1.98
2008	Maths/Chem	120	0.938	29.40	118	1.98
	Maths/Phy	120	0.954	34.57	118	1.98
	Maths/Bio	120	0.908	23.54	118	1.98
2009	Maths/Chem	120	0.924	25.50	118	1.98
	Maths/Phy	120	0.930	27.49	118	1.98
	Maths/Bio	120	0.826	15.92	118	1.98
2010	Maths/Chem	120	0.936	28.89	118	1.98
	Maths/Phy	120	0.955	34.98	118	1.98
	Maths/Bio	120	0.824	15.81	118	1.98

Simple percentages were used to analyze the data collected with regards to students' performances in mathematics and the science subjects selected for the study. To answer the research questions one, two and three; the Pearson product moment correlation coefficient was used. The t-test statistics was employed to test the significance of the hypotheses. This was done by converting the 'r' values accordingly to t-test at a test significance level of $p < 0.05$ (two tailed) for Ho1, Ho2 and Ho3. In Table 1, the Pearson's 'r' has been converted to t-test as shown under the column headed t-calculated. For the years 2007, 2008, 2009 and 2010 in the sample under study it can be seen that the t-calculated is consistently higher than the t-critical value. Hence it can be stated that there exists a significant relationship between mathematics and chemistry, physics and biology.

Research Question One and Null Hypothesis One (Ho1):

Research question one states: What is the relationship between achievement in mathematics and achievement in physics at WASSCE (2007-2010)? From Table 1 it can be seen that the relationship between mathematics and physics is both positive and strong for the years 2007, 2008, 2009 and 2010 for the sampled students' scores. This is indicated by the values 0.961, 0.954, 0.930 and 0.955 for the four years respectively. Hypothesis one states that there is no significant relationship between achievement in mathematics and achievement in physics at WASSCE. From Table 1 it can be seen that the t-calculated values for 2007, 2008, 2009 and 2010 were well above the critical value of 1.98 at 0.05 level of significance. The null hypothesis is thus rejected which implies that there is a significant relationship (37.75, 34.57, 27.49 and 34.98) between mathematics achievement and achievement in physics for the already stated years.

Research Question Two and Null Hypothesis Two (Ho2):

This research question states: What is the relationship between achievement in mathematics and

achievement in chemistry at WASSCE? Referring to Table 1, it can be seen that the relationship between mathematics and chemistry is positive and strong. This is indicated by the values 0.966, 0.938, 0.924 and 0.936 for the years 2007, 2008, 2009 and 2010 respectively. Null hypothesis two states: There is no significant relationship between achievement in mathematics and achievement in chemistry at WASSCE. The t-calculated values shown in Table 1 are indicative of the fact that there is a significant relationship between mathematics and chemistry at WASSCE. This is because the calculated t-values of 40.59, 29.40, 25.50 and 28.89 respectively for the years under study are all well higher than the critical t-value of 1.98 at 0.05 level. Thus the null hypothesis is rejected.

Research Question Three and Null Hypothesis Three (Ho3):

Research question three states: What is the relationship between achievement in mathematics and achievement in biology at WASSCE? Again we refer to Table 1, where the relationship between the two subjects for the years under study stands at 0.880, 0.908, 0.826 and 0.824 respectively. This relationship according to the standard rating is both positive and strong. Again referring to Table 1, the t-calculated values stand at 20.13, 23.54, 15.92 and 15.81 for the years 2007, 2008, 2009 and 2010 respectively, which are all higher than the critical value of 1.98 at 0.05 level of significance. This led to the rejection of null hypothesis three which states that there is no significant relationship between mathematics achievement and achievement in biology.

DISCUSSION OF FINDINGS

The findings of this study with regards to the relationship between mathematics and sciences confirm that chemistry is one of the science subjects that require a substantial mathematical base for its understanding (Ekpo and Usoro, 2011). While Manapure (2011) posits that a student needs basic knowledge of mathematics like change of subject of formula to understand a wide variety of topics in physics and biology. The study also agrees with Meltzer (2002) who stated that studies appear to show that mathematical ability or mathematical aptitude or accumulated procedural knowledge is positively correlated to success in traditional introductory physics courses that emphasize quantitative problem solving. In addition, Iji (2008), Kurumeh (2008) and Sidhu (2006) agree that for any science material to be assimilated by students, such a material must be presented in a mathematically understandable form. Furthermore, different mathematical topics such as vectors, calculus, logarithms and arithmetic are applied to solve scientific problems (Onwuka, Onwuka and Iweka, 2010). It is therefore worthy of note that when

students' potentials and resources are properly harnessed; achievement in mathematics can indeed have a productive effect on other science subjects. Also we note the theories on transfer of learning which enables students to use learned materials from one related subject to another. Students are able to learn once they have insight into the relationship that exists between the new and old material according to gestalt psychologists.

These findings are consistent with the findings of Anyor(2005) and Usoro and Ekpo (2011) who carried out separate researches to ascertain whether a multiple relationship exist involving students' performance in physics, chemistry and mathematics. It was established that there is a positive relationship between mathematics and science. In addition Miano (2008) is corroborated by Onwuka, Onwuka and Iweka (2010) who found out the existence of a correlation between performance in mathematics and Physics, the findings showed that the performance in physics and mathematics correlate significantly. This study has thus confirmed the inter-connectivity that exists in the content and context between mathematics and other science subjects, particularly chemistry, physics and biology.

CONCLUSION

This study set out to find the relationship or otherwise that exists between achievement in mathematics and each of chemistry, physics or biology. Findings of the study led to the rejection of all three hypotheses which were stated in the null form. The research therefore concludes that mathematics achievement and science achievement correlate positively and to a large extent significantly at W.A.S.S.C.E (2007-2010).

RECOMMENDATIONS

Having reached a conclusion to this study, the researchers made the following recommendations:

1. Mathematics which has been made core and compulsory to secondary school students is to be sustained, especially for science students.
2. Curriculum material as well as school work planners are to be guided by these finding which establish the relationship between mathematics and science and thus pay particular attention to provisions that encourage integration in school work. This will go a long way in taking care of compartmentalization, but rather improve on the general achievement of students at the secondary school level.
3. Teachers who directly handle students, especially those involved in research are to be actively involved in policy decisions that bother on academics as well as on the structure of education.

REFERENCES

Anyor, J. W. (2005). Relationship between students' achievement in mathematics and the sciences at the secondary school level. A dissertation submitted to the post graduate school Benue state university, Makurdi, in partial fulfillment of the requirements for the award of the degree of masters of education in mathematics.

D'Ambrosio, U. (2003). Stakes in mathematics education for the societies of today and tomorrow. Retrieved online on 6/9/2010 from www.unige.ch/.../m39.html.

Ekpo, U. & Usoro, D. (2011). Predicting students' performance in mathematics from their performances in physics and chemistry in Nigerian secondary schools. Retrieved on 14/6/2011 from www.aecollaborative.com/yahoo.

Emaikwu, S. O. (2010). Fundamentals of research methods and statistics. Makurdi: Selfers academic press limited.

Encarta (2006). Mathematics. Microsoft ® Encarta ® 2006. © Microsoft Corporation.

Encarta (2009). Transfer of learning. Microsoft ® Encarta® 2009. © Microsoft Corporation.

Eraikuemen and Oteza (2008). Students' choice of mathematics as a course of study. Implications for science and technological development. *Abacus*, 33(1), 64-69.

Federal Government of Nigeria (2004) .National policy on education (4th).

Gandhi D. B. (2010). Educational psychology: Gestalt theory of insightful learning. Retrieved on 22/7/2011 from www.dgwaymade.blogspot.com

Iji, C. O. (2008). Relationship between mathematics knowledge of Nigerian certificate in education (NCE) mathematics students and their performance in computer science. *Abacus, J.Math. Ass. Nig.*, 33(1): 42-48.

Kurumeh, M. S. (2006). Effective teaching strategies for mathematics education. In Ortese, P. T. (Ed), *Towards functional and qualitative education in Nigeria. A tribute to Dr. George Akume, executive governor of Benue state.* Makurdi: Destiny ventures.

Maduabum, M. A. & Odili, G. O. (2007). Trends in male and female students' performance in senior school certificate further mathematics in Nigeria. *Abacus, J.Math. Ass.Nig.*, 32(1): 115-123.

Manapure, V. (2011). Effect of further mathematics on students' achievement in mathematics, biology, chemistry and physics. Indian streams research journal, 1(2). Retrieved on 22/7/2011 from www.isrj.net/March_2011/006.pdf

Meltzer, D.E. (2001). The relationship between mathematics preparation and conceptual learning gains in physics: A possible hidden variable in diagnostic pretest scores. Retrieved on 3/7/2011 from www.physicseducation.net/docs/

Miano, P. M. (2008). The relationship between performance of mathematics and physics at KCSE in Kirinyaga District. Retrieved on 6/6/2011 from www.uonbi.ac.ke/./turntopdf.php

Olayemi, O. O. (2009). Students' correlates and achievement in mathematics as predictors of performance in physical chemistry. Abacus, J.Math. Ass.Nig., 34(1), 99-105.

Onwuka, F. O., Onwuka, P. I. & Iweka S (2010). Remediation of mathematics in physics as an enhancement strategy for achievement in physics education. Abacus, journal of the mathematical association of Nigeria, 35 (1), 120-126.

Sidhu, K. S. (2006). The teaching of mathematics. New Delhi: Sterling publishers.