OPEN ACCESS

World J Young Researchers 2011;1(4):60 ISSN 2249-0566

Oyedeji, 2011. Mathematics Skills as Predictors of Science Achievements

Original Article

Education Research

Mathematics Skills as Predictors of Science Achievement in Junior Secondary Schools

Samson Oyelola OYEDEJI

ABSTRACT [ENGLISH/ANGLAIS]

The purpose of the study is to investigate the predictive effects of the mathematics skills on the students' achievement in science in junior secondary school. A sample of 500 students was randomly selected from 10 Junior Secondary School 3 (JSS 3) in Benin metropolis, Edo State. A mathematics test titled "Test of Mathematics Skills" which covers the six mathematics skills considered was administered and the subjects' mock scores in science were collected from their records. The scores obtained in the mathematics test were correlated with their science scores to establish the relationship between mathematics skills and science achievement. Regression analysis was carried out to test the effects of the mathematics skills on the science achievement. The results revealed that there are significant correlations between the mathematics skills and science achievement. The result also showed that all the six mathematics skills i.e. computation skill, algebra skill, geometry skill, measuration skill, interpretation of graphs and tables and everyday statistics have direct effects on the science achievement in junior secondary school.

Keywords: Mathematics skills, science achievement, direct effects and indirect effects

RÉSUMÉ [FRANÇAIS/FRENCH]

Le but de l'étude est d'étudier les effets prédictifs des compétences en mathématiques sur la réussite des élèves en sciences à l'école secondaire de premier cycle. Un échantillon de 500 étudiants a été sélectionné aléatoirement à partir de 10 écoles secondaires junior 3 (JSS 3) dans la métropole du Bénin, l'Etat d'Edo. Un test de mathématiques intitulé «Test de compétences en mathématiques», qui couvre les compétences en mathématiques six considérée a été administrée et les scores des sujets se moquer de la science ont été recueillies auprès de leurs dossiers. Les scores obtenus au test de mathématiques ont étécorrélées avec leurs scores science pour établir la relation entre les compétencesen mathématiques et en sciences. L'analyse de régression a été réalisée pour tester les effets des compétences mathématiques sur le rendement en sciences.Les résultats ont révélé qu'il existe des corrélations significatives entre les compétences en mathématiques et en sciences. Le résultat a également montréque tous les six compétences en mathématiques des compétences de calcul à savoir, les compétences algèbre, la géométrie de compétences, compétencesmeasuration, l'interprétation des graphiques et des tableaux et des statistiquesquotidiennes ont des effets directs sur le rendement en sciences à l'écolesecondaire de premier cycle.

Mots-clés: Compétences en mathématiques, les résultats en sciences, les effets directs et indirects

Affiliations:

Demonstration Secondary School, University of Benin, Benin City, NIGERIA

Email Address for Correspondence/ Adresse de courriel pour la correspondance: oyelolasamson@yahoo.com

Accepted/Accepté : October, 2011

Full Citation: Oyedeji SO. Mathematics Skills as Predictors of Science Achievement in Junior Secondary Schools. World Journal of Young Researchers 2011;1(4):60-5.

INTRODUCTION

According to Aminu [1], the potential of a nation to develop in science and technology is a direct function of its adaptation in the area of mathematics. Hence the fact that mathematics is the corner stone of scientific and technological development cannot be over emphasized. Science is a body of knowledge about the universe. Science generally uses mathematics as a tool to describe it concepts. According to Haveys [2], mathematics turns out to provide a useful tool for expressing scientific concepts. The implication of this is that some basic understanding of the nature of mathematics is requisite for scientific literacy. Hence it is imperative that for students to perform well in science, they need to perceive mathematics as part of the scientific endeavour, comprehend the nature of mathematical thinking and become familiar with key mathematical ideas and skills.

Many authors have identified many basic skills in mathematics, which a secondary school learner of mathematics is expected to demonstrate before he/she can be said to be proficient in the subject. Trombley and Weiss [3] define basic mathematics skill as those skills that the majority of high school graduates would be able to perform successfully after exposure to the typical

mathematics curriculum. Trombley and Weiss [3] remarked that mathematics skill is a multifaceted construct that, in general, reflects the ability to do quantitative thinking, or more specifically, be able to discover, manipulate and evaluate relationships. According to National Council of Teachers of Mathematics [4], basic skills in mathematics must not be limited to routine computation at the expense of understanding, application and problem solving. The Council reiterated that the identification of basic skills in mathematics is a dynamic process and should be continually updated to reflect new and changing needs.

According to Odili [5], Harvey [2] and National Council of Teachers of Mathematics [4], ten basic skills areas were developed by National Council of Supervisors of Mathematics (NCMS). These are:

1) Problem solving – the principal reason for studying mathematics; posing questions, analyzing, translating and illustrating results, drawing diagrams, using trial and error, applying rules of logic, recognizing relevant facts, subjecting conclusion to scrutiny.
2) Apply Mathematics to Everyday Situation – interrelated with all computational activities; use everyday situations, translate them into mathematics expressions, solve, interprete results in the light of initial situation.
3) Alertness to Reasonableness of Results – calculating devices in society make this skill essential.
4) Estimation and Approximation – technique for estimating quantity, length, distance, weight etc; know when result is précised enough for purpose at hand.
5) Appropriate Computational Skills – addition, subtraction, multiplication, division with whole numbers and decimals and simple fractions; complicated computations will usually be done with a calculator. Knowledge of single digit number facts and mental arithmetic; use of percents should be developed and maintained.
6) Geometry – concepts of point, line, plane, parallel, perpendicular, basic properties of simple geometric figures with emphasis on measurement and problem solving; recognize similarities and differences among objects.
7) Measurement – minimally; measure distance, weight, time, capacity, temperature, and angles; calculate simple areas, volumes; use both metric and customary systems with appropriate tools.
8) Reading, Interpreting and Constructing Tables, Charts and Graphs – condensing information into manageable/meaningful terms and use conclusions with simple tables, maps, charts and graphs.
9) Using Mathematics to Predict – elementary notions of probability to determine likelihood of future events; identify immediate past experience that does not affect the likelihood of future events; use mathematics to help make predictions.
10) Computer literacy – understand what computer can/cannot do.

Odili [5] remarked that out of the ten basic skills highlighted Number and Numeration, Algebra process, Geometry, Measuration, reading of graphs and tables and Everyday Statistics are most needed in the learning of Junior Secondary School mathematics.

Many studies have been carried out on the relationship between mathematics and science. Wang and Santos [6] 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. Helfgott [7] noted that the close relationship between mathematics and physics goes as far back as the time of Euclid and Archimedes in the third century before the Common Era. This relationship, according to him, has been especially strong since Galileo established the modern conception of scientific method, wherein mathematics plays a crucial role, in the first decade of 17th century. He reported that the connection between mathematics and chemistry started in the 19th century; some two hundred years after a similar relationship had been consolidated between mathematics and physics. Despite this late interaction, according to Helfgott [7], important branches of chemistry, such as thermodynamics and chemical kinetics, have come to depend on mathematics.

Michelsen [8] reported that a permanent theme in physics education is the adequate level of mathematics language. Mastering mathematical formalism, according to him, is often a prerequisite for understanding physics. He noted that the lack of coordination between the curricula of physics and mathematics is one of the primary causes of students' difficulty of application of mathematics in physics. According to him, "it is difficult for the students to transfer concepts, ideas and procedures learned in mathematics to a new and unanticipated situation in physics".

According to New Jersey Mathematics Curriculum Framework [9], "Berlin and White [10] have identified six areas in which mathematics and sciences share concepts or skills; ways of learning, ways of knowing, process and thinking skills conceptual knowledge, attitudes and perception, and teaching strategies".

The purpose of this study, therefore, was to investigate the direct and indirect effects of the students' level of specific mathematics skills on science achievement. Specifically the study would answer the following questions:

1) Is there any relationship between students' level of mathematics skills and academic achievement in science?
2) Do the six mathematics skills have direct effects on the science achievement?
3) Is the contribution of the six mathematics skills to the prediction of science achievement significant?

For the purpose of this study and in accordance with Odili [5] the following skills were considered.

1) Computation skill – number bases, word problems, numbers in standard form; addition, subtraction, multiplication and division of fractions and decimals; rate, ratio and proportion.
2) Algebraic process skill – common factors, factorization of simple algebraic and quadratic expressions, solving equations; simple equations and equation involving fractions, simultaneous equations and word problems leading to equations and variation.
3) Geometry – geometrical constructions using ruler and compasses, finding the angles between two lines, angles in a right angled triangle using trigonometric ratios.
4) Measuration skill – areas of plane shapes (e.g rectangle, triangle, trapezium, circle etc), volumes of common solids (e.g cuboids, cylinder, cone etc) and areas and volumes of similar figures.
5) Interpretations of Tables and Graphs skill – interpretation of cost, travel and conversion tables and graphs, interpretation of statistical tables and graphs and interpretation of proportion graphs (direct and indirect)
6) Everyday Statistics – statistics averages, mixtures and probability

MATERIALS AND METHODS

Five hundred (500) students were randomly selected from junior secondary 3 (JS3) in Benin Metropolis. A mathematics test titled "Test of Mathematics Skills" was used for the study. The test was made up of 60 multiple choice questions with 10 questions on each mathematics skill. The science mock scores of the students used for the study were collected from their records. The mock examinations took place two weeks before the mathematics test was administered.

Three (3) mathematics teachers who have been teaching mathematics in Junior Secondary School 3 (JSS3) for more than five years established the content validity of the instrument. Gutman split-half method was used to establish the internal consistency of the instrument. A reliability coefficient of 0.84 was obtained. Out of the 500 questionnaires administered, 482 were finally analyzed.

Correlation matrix of the six skills was performed using SPSS version 15. Regression analysis was performed to determine the regression coefficients of the six mathematics skills considered.

The following was the proposed regression model:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6$$

Where a = constant term,

X_1 = computation skill, X_2 = algebra skill,

X_3 = geometry skill, X_4 = measuration skill,

X_5 = interpretation of graphs and tables, and

X_6 = everyday statistics and Y is the student's science achievement.

RESULTS

Relationship between the Students' Level of Mathematics Skills and Academic Achievement in Science

Table 1 shows the correlations between the mathematics skills and science achievement and correlations among mathematics skills. The result reveals that there are significant correlations between the mathematics

Skills and science achievement and all the correlation coefficients are positive. It is also revealed that the mathematics skills are positively correlated with each other.

Contribution of the Six Mathematics skills to Science Achievement

Table 2 shows the analysis of variance of the contribution of the six mathematics skills to the prediction of science achievement. The result reveals that the sum of squares of regression is 2799.892 while the mean square is 466.649. The sum of squares for residual is 4693.426 while the mean square is 24.573. The calculated F-value is 18.990 and is significant at .000 level. The value of R is .611 while the value of R^2 is .374. The adjusted R^2 is .354.

This result implies that the contribution of the six mathematics skills is significant at p<.05 and about 37.4% of the variance in the dependent variable (science achievement) is accounted for by the predictors.

Table 1: This table shows the correlations between mathematics skills and science achievement and correlations among the mathematics skills.

		COMP	ALGB	GEO	MEAS	INTERP	STAT	SCIEN
Correlation	COMP	1.000	.527	.510	.497	.396	.540	.475
	ALGB	.527	1.000	.563	.572	.283	.445	.391
	GEOM	.510	.563	1.000	.495	.290	.380	.491
	MEAS	.497	.572	.495	1.000	.293	.378	.476
	INTERP	.396	.283	.290	.293	1.000	.517	.383
	STAT	.540	.445	.380	.378	.517	1.000	.364
	SCIEN	.475	.391	.491	.476	.383	.364	1.000
Sig. (1-tailed)	COMP		.000	.000	.000	.000	.000	.000
	ALGB	.000		.000	.000	.000	.000	.000
	GEOM	.000	000		.000	.000	.000	.000
	MENS	.000	000	.000		.000	.000	.000
	INTERP	.000	000	.000	000		.000	.000
	STAT	.000	.000	.000	000	.000		.000
	SCIEN	.000	.000	.000	.000	.000	.000	

Table 2: This table shows the ANOVA of the contribution of the six mathematics skills to the prediction of science achievement.

Source of Variation	Sum of Squares	Df	Mean Square	F	Sig.
Regression	2799.892	6	466.649	18.990	.000(a)
Residual	4693.426	191	24.573		
Total	7493.318	197			

$p < 0.05$; a Predictors: (Constant), STAT, MEAS, INTERP, GEOM, COMP, ALGB; b Dependent Variable: SCIEN; R = .611; R^2 = .374; adjR^2 = .354

Effects of each of the six mathematics skills on student's science achievement

Table 3 shows the regression and Beta coefficients of the predictors. The result reveals that the B coefficients of computation skill (.461), algebra (.477), Geometry (.745), Measuration (.709), Interpretation of graphs and tables (.509), everyday statistics (.328) and the constant term (9.460) are all positive. The Beta coefficients of the predictors i.e path coefficients indicated that Computation skill has coefficient of .172, Algebra skill has coefficient of .105, Geometry has .251, Measuration has .223, Interpretation of graphs and tables has .178 and Everyday statistics has coefficient of .091. The t test statistics shows that the contributions of the Computation skill (2.208), Algebra (2.288) Geometry skill (3.375), Measuration skill (3.006), Interpretation of graphs and tables skill (2.622) and Everyday Statistics (2.121) to the prediction of science achievement are all significant at p<.05 level.

Table 3: This table shows the regression coefficients of the mathematics skills in the estimation/prediction of science achievement.

Variable	B	Std. Error	Beta	T	Sig.
(Constant)	9.460	1.088		8.692	.000
COMP	.461	.209	.172	2.208	.028
ALGB	.477	.232	.105	2.288	.023
GEOM	.745	.221	.251	3.375	.001
MEAS	.709	.236	.223	3.006	.003
INTERP	.509	.194	.178	2.622	.009
STAT	.328	.233	.091	2.121	.040

a Dependent Variable: SCIEN

The implication of these results is that each of the six mathematics skills significantly predicts junior secondary school students' science achievement.

The final regression model was as follows:

$Y = 9.460 + .461X_1 + .477X_2 + .745X_3 + .709X_4 + .509X_5 + .328X_6$

DISCUSSION

The result in table 1 revealed that all the six mathematics skills were highly positively correlated with the science

achievement and with each other. This implies that the students who did well in the mathematics test also did well in science mock examination and those who did not do well in the mathematics test did not also do well in science mock examination. This result was similar to the one obtained by Wang and Santos [6] in their study titled "A Comparative study of Relationship between Mathematics and Science Achievement at the 8th Grade. The result in table 2 also revealed that the contribution of the six mathematics skills, in unison, to the prediction of science achievement was significant. This was in support of the result obtained in table 1.

The educational implication of these results is that although it is often necessary to teach specific concepts and skills, mathematics must be approached as a whole; concepts, skills, procedures and intellectual processes are interrelated. New Jersey Mathematics Curriculum Framework [9] noted, "More generally, although students need to learn different skills and content areas in mathematics, they also need to see all learning interwoven. In a real sense, the whole is greater the sum of its parts. Thus, the curriculum in Junior Secondary School should include deliberate efforts, through specific instructional activities, to connect ideas, procedures and skills both among different mathematical topics and with science content areas. Throughout the Junior Secondary School, students need to develop their understanding of the relationship of mathematics to other subject areas especially science.

The result in table 3 indicated that the contributions of the six mathematics skills to the prediction of science achievement were significant $p < .05$. This shows that all the six mathematics skills do have predictive effects on science achievement.

The educational implication of these results is that mastering of the basic mathematics skills in Junior Secondary School is among the most important factors for success in science in Junior Secondary School. Hence there is need for coordination between the curricula of mathematics and science at Junior Secondary level. This will remove the difficulty of application of mathematics in science. It will help the students to transfer concepts, ideas and procedures learned in mathematics to a new and unanticipated situation in science.

CONCLUSIONS

Based on the results of this study, it can be concluded that students who do well in mathematics are expected to do well in science as well in junior secondary school.

RECOMMENDATIONS

It is recommended that there should be collaboration of mathematics and science teachers in Junior Secondary School to rearrange the curriculum contents of the two subjects such that the topic areas that are related in the two subjects can be treated simultaneously. This will help the students to transfer the concepts, procedures and skills that have been learnt in mathematics to science. In addition, "unifying mathematical ideas" should be employed. This means that the major mathematical themes that are relevant in several different strands are unified. Mathematics teachers should tie together individual mathematical topics, revealing general principles at work in several different strands and showing how they are related.

It is important that the curriculum planners identify correlations between mathematics skills and integrated science concepts in a teacher-friendly manner (tabular format).

Furthermore, science programme in junior secondary school should be coordinated with the Mathematics programme to enhance students use and understanding of mathematics in the study of science and to improve students' understanding of mathematics and science.

REFERENCES

[1] Aminu J. Combating poor Achievement in Mathematics. JMA. 1989;19:26-39.

[2] Harvey AH. Don't Blame Government for what I say, or vice versa. 2008. Retrieved from http://www.madsci.org/post/archive/2000-08/9666881978.sh.v.html Last Accessed on May 25, 2009.

[3] Trombley RJ, Weiss DJ. Measurement of Basic Skills in Mathematics. Berkeley, CA; National Centre for Research in Vocational Education. 1993

[4] National Council of Teachers of Mathematics. Agenda for Action: Basic Skills. Retrieved from http://www.ntcm.org/standards/content.asp?=1728. Last Accessed on May 4, 2011.

[5] Odili GA. Teaching Mathematics in Secondary School. Anachuna Educational Books. Akwa, Nigeria. 1986. p. 45-68.

[6] Wang J, Santos S. A Comparative Study of Relationship Between Mathematics and Science Achievement at 8th Grade. 2003. Retrieved from http://eric.ed.org/ERICWebportal/custom/portlets/recordsDetail/detailmin.jsp?_nfpb=true&_&ERICExtsearch_searchValue_0=Ed475359&ERICExtsearc

h_searchtype_0=no&accno=ED475359. Last Accessed on May 10, 2009.

[7] Helfgott M, Suny O. Mathematics and the Natural Sciences: Two examples from the Natural Sciences and their Relationship to the History and Pegogy of Mathematics. 2006. Retrieved from http://www.icme-organisers.dk/tsg17Helfgott-abs.pdf Last accessed on May 25, 2009.

[8] Michelsen C. expanding the Domain Variables and Functions in an Interdisciplinary Context between Mathematics and Physics. Retrieved from http://www.Imada.Sdu.dk/Michelsen_final_pp_201-214.pdf. Last accessed con May 25, 2009.

[9] New Jersey Mathematics Curriculum Framework. The first four Standards: Standard 3 – Mathematical Connection. 1996. http://www.state.nj.us/education/frameworks/math/math2.pdf Last accessed May 10, 2009

[10] Berlin DF, White AL. Integration of Science and Mathematics: What Parent can do. Colombus, OH: National Center for Science Teaching and Learning, 1993.

ACKNOWLEDGEMENT / SOURCE OF SUPPORT

Nil

CONFLICT OF INTEREST

Nil