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Effect of Further Mathematics on Students' Achievement in Mathematics, Biology, Chemistry and Physics

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Abstract: This study investigated the effect of Further Mathematics on students' achievement in mathematics, biology, chemistry and physics in Ogun State, Nigeria Two Local Government Areas (LGAs) were judgmentally selected from the state. Ten secondary schools were also purposively selected from the two LGAs (Five schools from each LGA). At least twenty students (Ten Further Mathematics and Ten non-further mathematics) participated in the study in each school. Two hundred students were used for the study. The design is experimental. The further mathematics group was the experimental group with further mathematics as treatment while the control group was the non-further mathematics group. All the students selected were offering mathematics, biology, chemistry and physics. A 100-item Achievement test was administered to the students. No further mathematics test was given. Exposure to further mathematics teaching for at least two years served as treatment. There was no significant difference between further mathematics and non-further mathematics groups in achievement in each subject. However, further mathematics students had significantly better overall achievement ($t = 2.012$, $p<0.05$). All science students should be encouraged to offer further mathematics.

Key words: Biology, Chemistry, Physics Achievement, Further Mathematics, Science Achivement, Secondary School Students.

INTRODUCTION

Further mathematics affords Senior Secondary School students opportunity to be introduced to some topics in Advanced Level mathematics in order to prepare them to study mathematics or mathematics-related courses in their next level of education. While all students offer mathematics, only few science students normally offer further mathematics. The reason for this is not far fetched. National Council for Curriculum Assessment (2005) noted that many students view mathematics as a difficult subject and perceive higher mathematics as an elite subject for only the best students. Akinsola and Ogunleye (2003) asserted that students could only find the study of mathematics more appealing when they perceive the subject matter as interesting, useful and relevant to their daily living.

It is logical to think that students who offer further mathematics have opportunities to perform better especially in mathematics than their counterparts who do not offer further mathematics. There is a term in education called 'opportunities to learn' Ground and Cebulla (2000) defined opportunities to learn with regards to mathematics and science as the extent of students have opportunity or chance to learn mathematics or any of the science subjects. This also bears directly on students' mathematics and science achievement. Brophy (2000) explained that in maximizing opportunity to learn, attention should not be given to wide coverage of the syllabi, but there should also be conscious efforts to teach content and skill involved deeply. It can then be inferred that students who offer further mathematics have better opportunity to learn more mathematical concepts than their counterparts that do not.

Many topics in the science subjects (biology, chemistry and physics) are inter-related. There are overlaps or areas of intercession in the content areas. Atomic structure is taught in physical chemistry as well as modern physics. Fermentation is a topic taught both in biology and chemistry. Many laboratory equipment used in one subject area can also be used in others. However, many topics in the science subjects cannot be understood without sound knowledge of mathematics.

Setidisho (1996) asserted that mathematics is a fundamental science which is necessary for understanding of most other fields. Probably, no subject forms such a binding force among the various branches of science - physical, biological and social as mathematics (Adetoye & Aiyedun, 2003). Mathematics is the language of science and central intellectual discipline of the technological societies (Kalejaye, 1985; odeyemi, 1995). A student needs basic knowledge of mathematics like change of subject to understand density which appears under major topics like Ecology in Biology, diffusion in Chemistry and Floatation in Physics. Vector quantities which is not taught in Ordinary Level Mathematics Syllabus is taught in Further Mathematics and Physics. Science students offering further mathematics therefore have a double opportunity to be taught vector quantities both in physics and further mathematics.

Students' achievement in mathematics at both Junior and Senior School levels worsen as years go by (Oyedeji, 1987). Many other researchers confirm low performance in mathematics at both the qualifying examination (SSCE) and placement examination like University Matriculation Examination – UME (Ukeje, 1991; Buhari, 1994 & Okoro, 2005). If the outcome of this study proves that science students who offer further mathematics perform better in mathematics and other science subjects, then mathematics may be recommended to all science students. This study therefore sought to find out the effect of Further Mathematics on students' achievement in Mathematics Biology, Chemistry and Physics in Ogun State Senior Secondary Schools, Nigeria.

Research Questions

i. Is there any significant difference between further mathematics and non-further mathematics students' achievement in mathematics, biology, chemistry and physics?

ii. Is there any significant difference between further mathematics and non-further mathematics students' overall achievement in mathematics, biology, chemistry and physics?

ii. Is there any significant difference between male and female students' achievement in mathematics and other science subjects?

iv. What is the relationship between each of the subjects (mathematics, biology, chemistry and physics) and other science subjects?

METHODOLOGY

Research Design

This study employed an experimental research design. There was one treatment group and also one control group. The treatment on the respondents was the teaching of further mathematics. This was already occurring as part of the normal school programme before the tests of mathematics, biology, chemistry and physics were administered.

Population and Sample

The target population for this study was all the Senior Secondary School students offering mathematics, biology, chemistry and physics in all the public schools in Ogun State.Two Local Government Areas were judgmentally selected from Ogun State. They are Ijebu-Ode and Ikenne Local Government Areas (LGAs). These two LGAs were chosen because they are in different zones in the state. Also many schools in the LGAs have been established for many years and therefore have further mathematics teachers. One of the problems encountered in the study was lack of students offering further mathematics in quite a number of schools.Five secondary schools were also purposively selected from each LGA. The selected schools had:

(i) Students offering further mathematics
(ii) Students who were willing to participate and teachers who were also willing to co-operate.
(iii) Students in SS 3 who have been introduced to further mathematics for at least two years
(iv) Presented students/candidates for West African Examinations Council(WAEC) or National Examinations Council (NECO) for at least 2 years.

At least ten further mathematics and ten non-mathematics students were randomly selected from each of the ten Senior Secondary Schools to participate in the study. However, only one hundred and four (104) further mathematics students and ninety six (96) non-further mathematics students submitted the test conducted under examination conditions. In other word, two hundred students participated in the study.

Instrumentation

An achievement test was used to collect data. The test was divided into four sections namely mathematics, biology, chemistry and physics. No further mathematics test was given. Each section of the test has 25 multiple-choice objective items with options A to E. The maximum obtainable score was 100. Students were asked to indicate their gender on the objective answer sheets as well as their identification number.The students were not asked to write their names on the answer sheets. They were given pre-determined numbers (called identification numbers) to write on their answer sheets, which allowed the research to separate the answer sheets into further mathematics and non-mathematics groups.

The researcher had earlier visited the schools to collect scheme of work and asked the mathematics, biology, chemistry and physics teachers for topics already taught. This was to ensure that the areas that would be covered in the test had been taught in all the schools. At the time of this study, almost all areas of the syllabi had been covered in all the subjects in all the schools. This was because the selected students were final year studenst who were about to write the Senior Secondary Certificate Examination. The items therefore covered different topics in the syllabi. The researcher also gave the test items to experienced science teachers to give their suggestions. Modifications were made based on suggestions given. All these precautionary measures were taken to ensure the content validity of the test.

Data Analysis

Data collected from the respondents were analysed using t-test statistics to compare means of two groups. Pearson product-moment correlation was used to find relationships among the science subjects.

RESULTS

Research Question1: Is there any significant difference between further mathematics and non-mathematics students' achievement in mathematics, biology, chemistry and physics?

Table 1 above shows that there is no significant difference between further mathematics and non-further mathematics students' achievement in mathematics, biology, chemistry and physics. This tends to suggest that the impact of further mathematics does not affect students' achievement in the identified subjects. However, the mean scores of further mathematics students are higher in each subject. This implies that though further mathematics students perform better than their non-further mathematics counterparts, the difference is not statistically significant. The mean achievement of students in the science subjects (except biology) clusters around average (12.5) as the maximum obtainable score in each subject is 25.In biology, the achievement is slightly above average for both further mathematics and non-further mathematics groups.

Research Question 2: Is there any significant difference between further mathematics and non-further mathematics students' overall achievement in mathematics, biology, chemistry and physics?

Overall achievement in mathematics, biology, chemistry and physics means the sum of students' scores in achievement test administered in these various subjects. This was done to determine if further mathematics would influence the overall students' achievement in these subjects. Interesting, there is significant difference between Further mathematics and non-further mathematics students' science achievement. Further mathematics students have better overall mean score than non-further mathematics students. The comparison of means using t-test statistics shows that the difference in achievement is statistically significant ($t = 2.012$, $p<0.05$). Though, exposure to further mathematics has no significant impact on student achievement in each of the identified subjects as presented in table 1 however, it has significant effect on the overall achievement.

Research Question 3: Is there any significant difference in male and female student achievement in the mathematics and other science subjects?

There is no significant difference in male and

Table 1: Comparison of further mathematics and non-further mathematics students' achievement in mathematics, biology, chemistry and physics

Subjects	Whether students are offering further math or not	N	Mean	Standard error mean	t	Significant value	Remark
Mathematics	Further maths students	104	13.048	0.462	0.489	0.124	NS
	Non-further maths students	96	12.115	0.382			
Biology	Further maths students	104	14.289	0.453	0.332	0.159	NS
	Non-further maths students	96	13.490	0.325			
Chemistry	Further maths students	104	13.358	0.438	0.912	0.070	NS
	Non-further maths students	96	12.521	0.359			
Physics	Further maths students	104	13.596	0.481	1.012	0.068	NS
	Non-further maths students	96	12.458	0.381			

Df = 198, NS = Not Significant

Table 2: Comparison of further mathematics and non-further mathematics students' overall achievement in mathematics, biology, chemistry and physics

	N	Mean	Standard deviation	Standard error	t	Sign value	Remark
Further math students	104	51.442	12.397	1.216	2.012	0.046	Significant $p<0.05$
Non-further math students	96	48.469	7.781				

df = 198

Table 3: Comparison of male and female student achievement in the various subjects

Subjects	Gender	N	Mean	Standard deviation	Standard error	t	Sign value	Remark
Mathematics	Male	109	12.587	4.243	0.406	0.046	0.963	NS
	Female	91	12.616	4.363	0.457			
Biology	Male	109	14.073	4.187	0.401	0.050	0.517	NS
	Female	91	13.703	3.787	0.397			
Chemistry	Male	109	13.073	4.002	0.383	0.051	0.959	NS
	Female	91	13.044	4.123	0.432			
Physics	Male	109	13.092	4.566	0.437	0.146	0.884	NS
	Female	91	13.000	4.227	0.443			
Overall achievement	Male	109	50.239	10.938	1.048	0.328	0.743	NS
	Female	91	49.747	10.049	1.054			

df = 198, NS = Not Significant (p>0.05)

Table 4: Correlation matrix of students' achievement in science subjects

	Mathematics	Biology	Chemistry	Physics	Overall
Mathematics	1.000				
Biology	0.512*	1.000			
Chemistry	o.588*	0.518*	1.000		
Physics	0.622*	0.553*	0.634*	1.000	
Overall	0.801*	0.811*	0.603*	0.847*	1.000

**Significant (p<0.05)*

female students' achievement in mathematics, biology, chemistry and physics. The overall achievement was computed by adding students' scores in each of the identified subjects. There is also no significant difference between male and female overall science achievement. The mean achievement of male and female students in the science subjects clusters around average (50.0) as the maximum obtainable score in each subject is 100.

Research Question 4: What is the relationship between each of the subjects (mathematics, biology, chemistry and physics) and other science subjects?

Table 4 above shows how each subject significantly and positively correlates or relates to each of the other subjects. 'Overall' in the table above means the sum of students' scores in mathematics, biology, chemistry and physics. Student performance in each of the subject correlates very highly and significantly with each other subject. The highest correlation is between physics and overall achievement ($r = +0.847$, $p<0.05$) while the lowest but also significant relationship in between mathematics and biology ($r=+0.512$, $p<0.05$).

DISCUSSION

Students offering further mathematics have an overall advantage over their non-further mathematics counterparts. This advantage though present but not statistically significant in each science subject. Being exposed to further mathematics is no more than being exposed to advanced topics in mathematics even while at Senior Secondary School level. Setidisho (1996) asserted that mathematics is a fundamental science which is necessary for the understanding of most other fields. Probably no other subject forms a strong binding force among the various branches of science – physical, biological and social as mathematics (Adetoye & Aiyedun, 2003).

Odousoro (2000) affirmed that mathematics has been found to be very important because it is needed for all scientific, technological research and technical training. Students who have been taught vector in further mathematics have advantage over non-further mathematics students in the physics class because of better entry behavior. No doubt, science subjects are inter-related, a student that is good at one is likely to be good at others. Science subjects have many things in common. Apart from the overlap of content in some topics, the principles of science teaching and learning such as observation, formulating hypotheses, drawing influences and recording cut across all the science subjects. Mathematics on the other hand according to Adetoye and Aiyedun (2003), forms a strong binding force among the various branches of science.

CONCLUSION

No doubt, offering of further mathematics is an advantage in understanding mathematics and other science subjects. Though, the effect is not significant in each of the subject, however, there is significant difference in the overall achievement of further mathematics and non-mathematics students, the former performed better. Mathematics is the language of science and it unites all the science subject. There is no science subject where at least elementary knowledge of mathematics is not required. Therefore, offering further mathematics at secondary school level provides further mathematics students opportunities to be exposed to advanced topics in mathematics which can enhance performance in mathematics, biology, chemistry and physics. If the effect of further mathematics can be very important at this level, no doubt this knowledge will provide a good foundation for students in tertiary institution especially for those who will later study mathematics and engineering.

RECOMMENDATIONS

All science students should be encouraged to offer further mathematics as this will enhance their performance in mathematics and other science subjects. Teachers of further mathematics should teach the subject very well so that students will understand and apply the knowledge in other subjects.

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