THE RELATIONSHIP BETWEEN PRE-SERVICE TEACHERS' PERFORMANCE IN MATHEMATICS AND SCIENCE IN THEIR END-OF-SEMESTER EXAMINATIONS

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ABSTRACT

Mathematics plays a huge part in a child's studies in science and it is seen as a tool of the sciences. This study employs a descriptive survey designed to find out the relationship between the achievement in Mathematics and Science achievement in the pre-service mathematics and science student teachers in three Colleges of Education in the Central Region of Ghana. Views were sampled through a 20-item Likert-type questionnaire from 240 Level 200 students and analysed using SPSS. Also, data from documents on the End of Semester Examinations results of students from 2018 and 2019 were analysed for the study. Data was subjected to frequency counts involving simple percentages and content analysis techniques using themes and comments from questionnaires. This was to address the research questions and corresponding hypotheses that 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 Integrated Science at 0.05 level of significance. Also, the students believe that their performance in Mathematics has a bearing in that of Integrated Science. The study therefore concludes that there exists a relationship between the performance in Mathematics and that of science and that the performance in Mathematics can be used to predict the performance in science. The study recommends that the necessity of Mathematics for Science students in Colleges of Education should be sustained and curriculum planners are to further incorporate content in both subjects involved in this study.

Keywords: *Academic performance, Mathematics, Science, pre-service student teachers, end-of-semester examinations*

1. INTRODUCTION

Mathematics plays more of a role in our lives than many people realize. Mathematics also plays a huge part in a child's studies in science. Although Science may appear to be quite a different subject, the study of Mathematics can ultimately help your child more readily understand concepts in science. At its essence, Science is the study of how the universe and the things that exist in this universe work. Mathematics can help scientists find relationships between an experiment's hypothesis and the data that has been collected. By using statistics, scientists can use data as evidence to either support or dispute their original theories. Without the application of mathematics in this regard, proving or disproving scientific theories would be impossible.

Hill, Rowan, and Ball posit that the ability to accurately determine calculations or scientific principles is largely the result of the relationship between Mathematics and Science [1]. In Physics, calculus, and differential equations are used to study complex relationships between one property and another. Some examples of this are the centripetal

force a moving object exerts or the gravitational force that the Earth has on its satellites, including the moon. Chemistry also requires a substantial amount of Mathematics to estimate the quantity of an alkaline that will be needed to neutralize an acid during quantitative analysis. Manapure underscores the need for basic knowledge in Mathematics by students like change of subject of a formula to understand density which appears under major topics like ecology in Biology, diffusion in Chemistry, and floatation in Physics [2]. Also, Biology deals with the growth rate of organisms like human beings, both chemistry and physics considers the growth rate of crystals. Chemistry goes further to talk about rates of chemical reactions. Such a topic can best be understood with in-depth knowledge in Mathematics. These are the reasons why Galileo Galilei, a 16th century Mathematics scholar, is speculated to have said "Mathematics as a subject as well as a field of study is seen as the language of the sciences." There are many topics in the sciences (biology, chemistry, and physics) that overlap or are interrelated. Many of these interrelated topics need a better understanding of Mathematics for easy understanding.

1.1 Statement of the Problem

The science (biology, chemistry, and physics) requires the use of Mathematics knowledge in many applications as it has already been established. It is also logical to think that there exists a marked educational gain in offering mathematics while offering science subjects as 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" [3]. There are branches or aspects of Mathematics that are appreciated by only a few; so, it may be in place to think that Mathematics is in a greater danger of going into irrelevance than the other sciences [4].

In Ghana, however, Mathematics has been made core and compulsory, especially for the sciences in gaining admission into post-secondary institutions of learning especially those who enter into Colleges of Education. This has not gone down well with some stakeholders, especially students and parents or guardians who sometimes simply state that they "I don't like Mathematics" or "Mathematics is too abstract" thereby questioning its usefulness to the student at this level.

However, the students entering into the Colleges of Education offer Mathematics and Integrated Science as a fundamental course, that is a core course. This is in line with the Ghana Education policy of teaching Mathematics and Science at all levels in basic education. This equips the teacher to handle these two subjects after completing college in other to teach at the basic level with ease and competence. In recent times, the curriculum structure of the Colleges of Education has been changed. The curriculum has now been designed in such a way that not all students offering Science courses read Mathematics and vice versa. Thus, the thrust of this research is: what is the relationship between the achievement of students in Mathematics and Science at the End of Semester Examinations organized by the Institute of Education, University of Cape Coast?

1.2 Purpose of the Study

The study seeks to find the relationship that exists between students' achievement in Mathematics and Integrated Science in their End of Semester Examinations organized by the Institute of Education, University of Cape Coast. The study also tries to find out if achievement in Mathematics can be used to predict achievement in science.

1.3 Hypothesis of this Study

In many cases, the purpose of research is to answer a question or test a prediction. These predictions are generally stated in the form of hypotheses (hypothesis, singular form) which are testable propositions. The following hypothesis was formulated to guide the study. That is;

*Ho*1. There is no significant relationship between students' achievements in Mathematics and Integrated Science at the End of Semester Examinations scores.

The alternative hypothesis for Ho1 is:

H_a1There is a significant relationship between students' achievements in Mathematics and Integrated Science at the End of Semester Examinations scores.

2. LITERATURE REVIEW

There has been a sharp decline in the academic performance of students from public basic schools in rural communities in Ghana over the past two decades especially in the area of Mathematics. Government efforts to remedy the situation have not yielded any enduring positive results [5]. Several factors have generally been identified as causes of poor academic performance at the basic school level of education in Ghana.

One such cause is teacher intelligence, competence, and knowledge in what they teach as reported by Wahyuddin [6]. If teachers know what they teach and the right pedagogy to deliver that content, it will increase the performance of their learners. It will not be far from right if Mathematics and Science teachers can link their content well to help their learners do well in both subjects. This is the subject matter of this study.

2.1 Mathematics as a Tool for the Sciences

According to Bailly, and Longo, Mathematics is seen as an essential tool in the physical sciences [7]. They further posit that anyone interested in pursuing a science-career will not get very far without a solid understanding of Mathematics. Kurumeh, Igyu, and Mohammed cited Eraikhuemen and Oteza that, the importance of Mathematics to Science requires that Mathematics be regarded as a basic tool for the teaching and learning of science [8; 9]. In Chemistry, Mathematics is an essential part of evaluating any chemical equation. Wagh and Deshpande described Mathematics as "an essential tool for Physics" and Physics was also described by Hitchin as "a rich source of inspiration and insight in Mathematics" [10; 11]. Mathematics has also become pervasive in Biology, taking many different forms: statistics in experimental design; pattern seeking in bioinformatics; models in evolution, ecology, and epidemiology; and much else [12].

Mathematical approaches allow the use of genetic data to analyse multi-locus traits, which are so important, for example, to plant breeding, and have made possible a much more quantitative approach to such issues. Perhaps the greatest challenge for computational and mathematical biology will come in dealing with the problems of global change, biological diversity, and sustainable development, which will require the integration of enormous data sets across disparate scales of space, time, and organization. To this end, it is essential for students studying the sciences, especially physics to have a greater knowledge of Mathematics. Students should also envisage where they will apply their mathematical knowledge in the sciences and get serious with it.

2.2 Theoretical Framework

The study was guided by Thorndike and Woodworth's theory of transfer of learning. According to this theory, learning can be transferred from one activity to another if the two activities are highly similar and share many common elements [13]. This theory explains how the learning in one subject area can be applied or influences another subject area. Gui, Xu, Lu, Du, and Zhou explained that transfer can either be considered positive or negative. To them, transfer of learning is positive when the learning or training carried out in one situation proves helpful to learning in another situation. For example, the knowledge and skills acquired in terms of addition and subtraction in mathematics in school may help a student in the determination to combine two or more resisters arranged either in series or parallel. Gui, *et al* further explained transfer as negative when what is learned in one context hinders or delays learning in a different setting. This study is more interested in the positive transfer of learning.

3. METHODOLOGY

The research is a descriptive survey through which views and opinions were sampled from teachers and students alike. The study covers teachers and students of three (3) colleges of education in the Central Region of Ghana out of the forty-six (46) Public Colleges of Education in Ghana. This region is the centre of learning in the country, is used to give credence to this research. This population is the targeted group of people of interest for the study. A total of 252 students were sampled using proportional sampling from each of the 3 colleges and the courses offered. This ensured that each college and course was well represented. Aside from the students, a total of 15 teachers consisting of 7 Mathematics and 8 Science teachers also participated in the study.

The study involves the inspection, collection, and analysis of data that had already occurred in the form of students' achievement test scores. Also, views were sampled from students and tutors using an 8-item Likert-type questionnaire. The data collected was analysed using appropriate descriptive statistics which allowed the researcher to use numerical values to represent scores in the sample The questionnaire was analysed using frequency counts and percentages. Data from documents on the End of Semester Examinations scores of students were analysed using correlation graphs.

4. DATA PRESENTATION AND ANALYSIS OF RESULTS

The purpose of this study was to ascertain the relationship that exists between students' achievement in Mathematics and Integrated Science in their End of Semester Examinations scores. This section presents the data collected and the analysis of the results.

4.1 Research Question 1

Research Question 1 reads "What is the relationship between the achievements of Mathematics and Integrated Science at End of Semester Examinations organized by the Institute of Education, University of Cape Coast?"

Table -1: Students' Responses to the Relationship between Mathematics achievement and achievement in Integrated Science

STATEMENT Percentage	SA F (%)	A F (%)	U F (%)	D F (%)	SD F (%)	TOTAL
1. Some topics in science need mathematical knowledge to understand.	150 (62.50)	68 (28.30)	0 (0.00)	14 (5.85)	8 (3.35)	240 (100)
2. I find mathematical concepts in science difficult when mathematics is not taught well.	68 (28.30)	150 (62.50)	2 (0.83)	15 (6.26)	5 (2.08)	240 (100)
3. When I understand mathematics well, I can perform better in science.	113 (47.08)	101 (42.08)	0 (0.00)	15 (6.26)	11 (4.58)	240 (100)
4. I do not necessarily need mathematics to perform well in science.	15 (6.26)	42 (17.5)	4 (1.66)	128 (53.33)	51 (21.25)	240 (100)
5. Mathematics and science complement each other.	128 (53.33)	92 (38.32)	8 (3.35)	7 (2.92)	5 (4.58)	240 (100)
6. There is a relationship between the performance of mathematics and science	70 (29.00)	146 (61.00)	2 (0.83)	10 (4.37)	12 (5.00)	252 (100)
7. Mathematics serves as a tool for the sciences	80 (33.33)	100 (41.67)	0 (0.00)	40 (16.67)	20 (8.33)	240 (100)
8. My understanding of science is difficult when my knowledge of mathematics is low	78 (32.50)	99 (41.25)	0 (0.00)	50 (20.64)	13 (5.56)	240 (100)

Table 1 presents a detailed outline on how the respondents responded to the eight (8) items on research question 1. These items were designed to seek the views of respondents on the relationship between Mathematics achievement and achievement in Integrated Science.

From Table 1, it can be inferred that 218 of the respondents representing 90.83% agreed with the statement 'some topics in Science need mathematical knowledge to understand' as opposed to 22 respondents representing 9.17 % who disagreed. This indicates that the majority of the respondents believe that some topics in science need mathematical knowledge to be understood. In the opinion of the respondents, there is a relationship between the performance of mathematics and science. A greater percentage (90%) of the respondents agreed with this statement as opposed to only 38 (9.37%) who disagreed.

Table -2: Tutors' Responses to the Relationship between Mathematics achievement and achievement in Integrated Science

STATEMENT Percentage	SA F (%)	A F (%)	U F (%)	D F (%)	SD F (%)	TOTAL
9. Some topics in science need mathematical knowledge to understand.	5 (33.33)	5 (33.33)	2 (13.34)	2 (13.34)	1 (6.66)	15 (100)
10. Students find mathematical concepts in science difficult when mathematics is not taught well.	7 (46.66)	5 (33.30)	0 (0.00)	2 (13.34)	1 (6.66)	15 (100)
11. Students who are strong in mathematics perform better in science.	12 (80.02)	1 (6.66)	1 (6.66)	1 (6.66)	0 (0.00)	15 (100)
12. Students do not necessarily need mathematics to perform well in science.	2 (13.34)	2 (13.34)	1 (6.66)	6 (40.00)	4 (26.68)	15 (100)
13. Mathematics and science complement each other.	4 (26.68)	8 (53.33)	1 (6.66)	2 (13.34)	0 (0.00)	15 (100)
14. There is a relationship between performance of mathematics and science	3 (28.97)	7 (46.66)	2 (13.34)	1 (4.37)	2 (13.34)	15 (100)
15. Mathematics serve as a tool for sciences	4 (26.68)	7 (46.66)	1 (6.66)	2 (16.67)	1 (6.66)	15 (100)
16. Students understanding in science is difficult when their mathematics knowledge is low	8 (53.34)	5 (33.34)	1 (6.66)	1 (6.66)	0 (0.00)	15 (100)

Table 2 gives tutors' responses to the relationship between Mathematics achievement and achievement in Integrated Science. The tutor observed that students who are strong in mathematics perform better in science lessons. 86.68% of respondents agreed whilst 6.66% of them disagreed. Surprisingly, 86.68 % of the respondents were of the view that students understanding in science lessons becomes difficult when their mathematics knowledge is low.

4.2 Analysis of Students End of Semester Examinations Results

The existing results of 240 students for the years 2014 and 2015 were analysed using the Pearson product-moment correlation coefficient. A graph of Science against Mathematics was plotted using a Microsoft Excel scatter plot (Chart -1 and Chart -2). It can be seen from the graph that there is a linear positive relationship between the results of Mathematics and that of science. This positive relationship is strong as well.

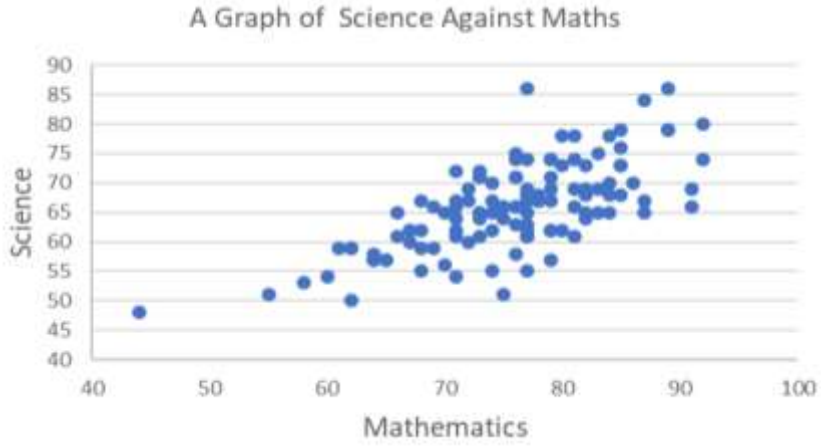

Chart -1: Correlation Graph of Students' Performance for the year 2014

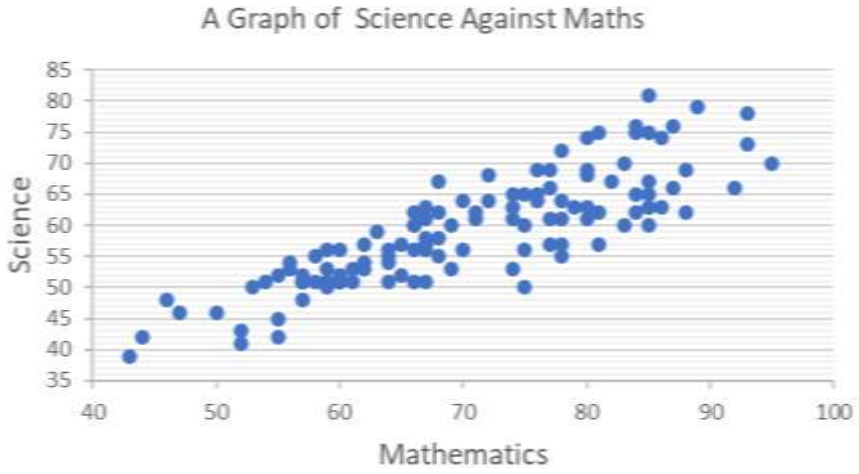

Chart -2: Correlation Graph of Students' Performance for the year 2015

The t-test statistics were employed to test the significance of the null hypothesis 1 (Ho1). This was done by converting the 'r' values accordingly to the t-test at a test significance level of $p<0.05$ (two-tailed) for Ho1. In Table 3, Pearson's 'r' has been converted to a t-test as shown under the column headed t-calculated. For the years 2014, and 2015 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 Integrated Science.

Table -3: Correlation Coefficient and t-test for correlation between Mathematics and Science for 2014 and 2015

Year	N	Correlation (r)	t-calculated	difference	t-critical
2014	240	0.689	9.630	118	1.9803
2015	240	0.845	7.174	118	1.9803

4.3 Discussion and Findings

The findings of the study show that both students and teachers in Colleges of Education believe that there is a relationship between Mathematics and Science and one needs a good background in Mathematics to perform well in science. This is in agreement with the finding of Manapure who posits that a student needs basic knowledge of Mathematics like the change of subject of formula to understand a wide variety of topics in Physics and Biology [2]. This idea is supported by Frykholm and Meyer in their statement "Unlike the Mathematics teacher who can choose to avoid Science, the Science teacher is not able to cover most topics without calling on mathematical concepts and skills" [15].

Referring to Table 3, it can be seen that the relationship between Mathematics and Science is positive and strong (Chart -1 and Chart -2). This is indicated by the values 0.689 and 0.845 for the years 2014 and 2015 respectively. The null hypothesis one states: 'There is no significant relationship between achievement in Mathematics and achievement in Integrated Science at End of Semester Examinations organized by the Institute of Education, University of Cape Coast'. The t-calculated values shown in Table 3 are indicative of the fact that there is a significant relationship between Mathematics and Integrated Science at the End of Semester Examinations. This is because the calculated t-values of 9.63 and 7.174 respectively for the years under study are all well higher than the critical t-value of 1.98 at 0.05 levels. Thus, the null hypothesis is rejected.

The findings of this study concerning the relationship between Mathematics and Integrated Science confirm that the study of science requires a substantial mathematical base for its understanding. 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, it was noted that the theories on the transfer of learning enable

students to use learned materials from one related subject to another. Students can learn once they have insight into the relationship that exists between the new and old material according to Gestalt psychologists [16].

5. CONCLUSIONS

This study set out to find the relationship or otherwise that exists between achievement in Mathematics and Integrated Science. The findings of the study led to the rejection of the null hypotheses. The research therefore concludes that Mathematics achievement and achievement in science correlate positively and to a large extent significantly at the End of Semester Examinations organized by the Institute of Education, University of Cape Coast (2014 – 2015).

5.1 Recommendations

It emerged from the study that, Mathematics plays an important role in the study of Integrated Science. Therefore, it is recommended that:

1. Mathematics which has been made core and compulsory in Colleges of Education be sustained, especially for all students offering Science courses.
2. Curriculum material as well as school work planners are to be guided by these findings 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 bridging the gap between Mathematics and Science to improve the general achievement of students at all levels.
3. The tutors of Mathematics and Science be given a platform where they can discuss issues of common interest to improve students' performance.

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