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Further Mathematics Content Coverage and First Year Mathematics Students' Algebra and Calculus Performance in Universities in Rivers State, Nigeria

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Abstract The desire for a technologically developed nation has made Nigeria to include Further Mathematics as a secondary school subject to mathematically prepare tertiary institution students that intend to study Mathematics or its applications. This study therefore, investigated the correlation between Further Mathematics content coverage and first year Mathematics students' Algebra and Calculus performance in Universities in Rivers State, Nigeria. Three research questions were answered and two null hypotheses were tested at 0.05 alpha level. The expost facto research design was employed. The census sampling technique was employed to select a sample of 86 BSc and BSc/Ed University first year Mathematics students from the three Universities in Rivers State. Two instruments titled Further Mathematics Content Coverage Checklist (FM3C) and Algebra & Calculus Performance Remark Sheet (ACPRS) were used to collect data. The mean and standard deviation were used to answer the research questions while the Pearson Product Moment Correlation analysis was used to test the hypotheses at 0.05 significant level. The findings of the study revealed that the extent of Further Mathematics content coverage by students is low and superficial; there is a significant relationship between Further Mathematics content coverage and academic performance of Mathematics students in University first year Algebra and Calculus courses. Based on the findings of the study, it was recommended among others that Mathematics teachers should endeavour to improve on the extent of Further Mathematics content coverage and also implement indepth teaching of the contents. It was therefore concluded that there is a positive high correlation between Further Mathematics content coverage and students' performance in University first year foundation (Algebra & Calculus) courses.

Keywords Further Mathematics, Content coverage, University Mathematics, Algebra, Calculus

1. Introduction

Mathematics is a compulsory subject at the secondary school level because of its utility in the society. The subject matter of Mathematics cuts across every discipline in a varied degree. Onwudire (2015) posited that everybody as well as every nation needs the presence of Mathematics for development. Given that Mathematics is very important for personal, organisational and societal development, it has been globally observed that the content of the General or Ordinary Mathematics is not sufficient for some higher courses in the tertiary institution. Hence, the emergence of Further Mathematics as a school subject. The Nigerian society keyed into this global trend and advocated that Further Mathematics should be included as one of the senior secondary school subjects. Participation of students in Further Mathematics is expected to increase undergraduate students' participation in courses such as the Sciences, Engineering, Mathematics and Technology (Lyakhova and Neate, 2018).

Gbamibole (2013) simply defined Further Mathematics as a computational subject that has the rudiments of advance Mathematics. Further Mathematics deals with higher secondary school Mathematics. Further Mathematics is relatively a new curriculum in Nigerian Educational System. Odili and Asuru (2011) posited that the introduction of Further Mathematics into Nigerian school curriculum was one of the recommendations of a national workshop on policies and strategies for the improvement of the teaching and learning of Mathematics at all levels organized by the National Mathematics Centre (NMC). 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 the tertiary institution. The subject matter

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of Further Mathematics broadens and deepens the pure and applied mathematical knowledge of students. This may suggest why (Lyakhova and Neate (2018) summised that students find it challenging to connect the Mathematics learnt at secondary school and the Mathematics learnt at the University.

The objectives of the Nigerian Further Mathematics curriculum are to:

1. Develop conceptual and manipulative skills in Mathematics so as to prepare students for Further studies in Mathematics and its application.
2. Reflect continuity with those used in Universities, Polytechnics, Federal colleges of education so that graduates of the curriculum have nothing to unlearn on entering any of the above mentioned institutions.
3. Develop advance mathematical skills in potential mathematicians, engineers and scientists. (NERDC, 2012)

All school subjects have curriculum. Further Mathematics is not an exemption. Further Mathematics curriculum is the official document that prescribes the content of advance mathematical concepts that the teacher is expected to implement in the classroom alongside with performance objectives, teacher and student activities, the instructional strategies and materials. Abamba (2012) asserted that teaching is content bound. This implies that the curriculum content is expected to be covered by the students before they enter any examination. This is because examination questions are posed with respect to curriculum content and the learnt subject content will be a springboard for higher content assimilation and accommodation. A situation where the students cover the Further Mathematics curriculum (partially, completely, shallowly or indepth) and sits for the subject examination (internal or external), what is the possible performance trend of such group of students.

It is a benchmark that every university, polytechnic or college of education first year student of Mathematics, Engineering and the Sciences offers Algebra and Calculus as foundation courses in their first year, first and second semester respectively. The course content of these two foundation courses are continuation of Further Mathematics which they learnt in secondary school and as such form the springboard for better appreciation of the foundation courses. This is in line with one of the objectives of Further Mathematics curriculum. The extent of Further Mathematics content coverage by students in secondary school is very crucial to the Algebra and introductory calculus course they are to offer in first year. Jalade (2016) posited that Algebra and Calculus are the most widely studied fact in all of University Mathematics and sciences. These two foundation courses are not just for students of Mathematics, Engineering and sciences but it also has applications in areas such as Business and Economics.

Babatunde (2014) investigated the effect of Further Mathematics content coverage in secondary schools in Kwara State and found out that students hardly cover the contents of Further Mathematics before sitting for their secondary school terminal external examination. Akajaike (2013) carried out a study and found out that there is a positive high correlation between students Further Mathematics content coverage and their performance in Engineering. Udom (2015) in a related study found out that there was a significant relationship between students Further Mathematics result in West African Senior Secondary Certificate Examination (WASSCE) and their performance in University Physics course. In order to successfully take the first year Algebra and Calculus courses, a student should have covered to a high extent the content of Further Mathematics. The question that arise is; does the extent of coverage of Further Mathematics content have any relationship with the academic performance of University first year Mathematics students in the Algebra and Calculus? It is against this backdrop that this study sought to investigate the correlation between Further Mathematics content coverage and first year Mathematics students' Algebra and Calculus academic performance in Universities in Rivers State, Nigeria.

Statement of the Problem

Further Mathematics is an advanced Mathematics subject which is learnt in senior secondary school by students who prospect to study courses that require higher mathematical knowledge in tertiary institutions. The curriculum content of Further Mathematics is broad and the content of the subject is expected to be taught to broaden the higher mathematical knowledge of students. The WAEC chief examiner (2013, 2014, 2016 and 2017) reported that students performance have continuously fallen below standard and attributed this poor performance to non coverage of the Further Mathematics curriculum content by students. The chief examiner has also advised students and teachers to ensure coverage of the Further Mathematics curriculum content before examination since questions are set based on the entire curriculum content and not just only the area that they have covered. The content of Further Mathematics is a pre requisite to the University first year Algebra and Calculus courses. Given that content coverage are in varied degree, could the extent of Further Mathematics content coverage have any relationship with students' performance in University first year Algebra and Calculus courses?

Objectives of the Study

The purpose of this study was to investigate the relationship between Further Mathematics content coverage and first year students' Algebra and Calculus performance in Universities in Rivers State, Nigeria.

Specifically, the objectives of the study were to:

1. Find out the extent of students' Further Mathematics content coverage in secondary school.
2. Ascertain the relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Algebra course.

3. Ascertain the relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Calculus course.

Research Questions

The following three research questions guided the study.

1. What is the extent of students' Further Mathematics content coverage in secondary school?
2. What is the relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Algebra course?
3. What is the relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Calculus course?

Hypotheses

The following two null hypotheses were tested at 0.05 significant level.

HO1: There is no significant relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Algebra course.

HO2: There is no significant relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Calculus course.

Research Design

The ex-post facto research design was employed for this study. The use of this research design was necessitated as a result of the researchers' inability to manipulate the variables (Further Mathematics content coverage and Mathematics students' first year Algebra and Calculus courses result) for the simple reason that they had already occurred.

Population of the Study

The population of the study consisted of all the eighty six 2016/2017 academic session first year BSc and BSc/Ed Mathematics students in the three Universities in Rivers State.

Sample and Sampling Technique

The census (complete) sampling technique was employed to select a sample of eighty six (86) BSc and BSc/Ed Mathematics students. This sampling technique was deemed necessary due to the small number of students in the population.

Instrument for Data Collection

Two instruments were used to collect data. The first instrument was Further Mathematics Content Coverage Checklist (FM3C) which had two sections. Section A sought information on students' demography while section B was used to ascertain the extent of Further Mathematics content coverage. FM3C was designed in a modified four-point Likert's scale of Very High Extent ={VHE (4), High Extent =HE (3), Low Extent =LE (2) and Very Low Extent = VLE (1)}. Responses that indicated VHE and HE were categorised into covered contents while responses that indicated LE and VLE were categorised into not covered contents. The criterion mean for FM3C was 2.5. FM3C consisted of twenty five Further Mathematics topics of various themes which students are expected to indicate the extent of content coverage when they were in secondary school.

The second instrument was a researcher constructed Algebra & Calculus Performance Remark Sheet (ACPRS) of first year Mathematics students. ACPRS was used to record students' academic performance of the Algebra & Calculus course mark sheets obtained from the sampled Universities Department of Mathematics. ACPRS was made up of 86 x 7 matrix formation (86 rows and 7 columns). The 86 rows made up each sample student Algebra and Calculus result particulars. The first column was students' serial number, second column was students matriculation number, third column was students' gender, fourth column was students' performance score in Algebra and the fifth column was students' performance score in Calculus. Each of the courses was graded over one hundred.

Validity of the Instrument

FM3C and ACPRS were validated by two experts in Mathematics and Mathematics education. The two instruments were presented to them to ascertain their face and content validity. The anomaly pointed out by the experts was corrected before using the instruments for the collection of data.

Reliability of the Instrument

The reliability of FM3C was ascertained using pilot study. 20 first year Mathematics students were selected from a tertiary institution that was not part of the study. FM3C was administered to this group of students and after two weeks, the same FM3C was re-administered to the same group of students. The Pearson Product Moment Correlation coefficient was used to obtain a reliability index of 0.83.

Method of Data Collection

FM3C was administered to the sample on a face to face mode. FM3C was administered to the sample by the researchers and retrieved from them on the same day to minimize misplacement of instrument by the sample. The students were guided by the researchers on how to respond to the instrument.

The first and second semester courses (Algebra and Calculus) result of sample was collected by the researchers from the result computation officers of the first year students with the permission of the Heads of Departments of the sample students. The researchers were not allowed to make photocopy of the result, so the information on students Algebra and Calculus result was documented from the mark sheet to ACPRS.

Method of Data Analysis

The mean and standard deviation was used to answer the research questions while the Pearson Product Moment Correlation analysis was used to test the hypotheses at 0.05 significant level.

2. Results

Research Question 1: What is the extent of students' Further Mathematics content coverage in secondary school?

Table 1. Extent of Further Mathematics content coverage

Topics	Mean	Std. Dev.	Remark
1. Sets	3.81	1.84	CC
2. Binary operation	2.27	1.03	CNC
3. Indices	3.69	1.72	CC
4. Logarithms	3.58	1.35	CC
5. Surds	3.53	1.39	CC
6. Functions	1.49	1.26	CNC
7. Sequences	1.03	1.51	CNC
8. Series	1.21	1.37	CNC
9. Linear inequalities in 2 variables	1.73	1.81	CNC
10. Trig ratios of special angles	2.68	1.04	CC
11. Logical reasoning	2.35	1.27	CNC
12. The straight line	1.38	1.65	CNC
13. Vectors in 2-dimensions	1.52	1.03	CNC
14. Roots of quadratic equations	2.79	1.66	CC
15. Polynomials	1.28	1.83	CNC
16. Trigonometric functions	1.47	1.15	CNC
17. Binomial expansion	2.05	1.04	CNC
18. Differentiation	1.37	1.38	CNC
19. Conic section: The circle	1.35	1.27	CNC
20. Matrices	2.57	1.74	CC
21. Determinants	2.82	1.03	CC
22. Partial fraction	1.64	1.44	CNC
23. Integration	1.56	1.63	CNC
24. Operations research	1.12	1.73	CNC
Overall Mean	**2.01**	**1.35**	**CNC**

Criterion mean = 2.5; CC = Content Covered; CNC = Content Not Covered

Table 1 showed the extent of Further Mathematics content coverage by students when they were in secondary school. From Table 1, out of the 24 topics listed in FM3C, it is evident that students covered only 8 topics (mean of each of these 8 topics were > 2.5). The 8 topics they covered were sets, Indices, Logarithms, Surds, Trigonometric ratios of special angles, roots of quadratic equations, matrices and determinants. Table 1 also revealed that students did not 16 topics listed in FM3C. Reason been that the mean of each of these 16 topics were < 2.5. A close look of table 1 also revealed that students covered more of Algebra contents than Calculus contents. The overall mean of 2.01 was less than the criterion mean of 2.5, and this implies that the overall Further Mathematics contents were not covered.

Research Question 2: What is the relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Algebra course?

HO1: There is no significant relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Algebra course.

Table 2. Summary of regression analysis on the relationship between students' Further Mathematics content coverage and their academic performance in university first year algebra course

A. Descriptive Statistics

	Mean	Std. Deviation	N
ACG	62.1047	12.73904	86
FMG	54.4070	12.89631	86

ACG: Algebra Course Grade

FMG: Further Mathematics Grade

B. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.667[a]	.445	.439	9.54262

a. Predictors: (Constant), Further Mathematics Grade

C. ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	6144.881	1	6144.881	67.480	.000[b]
	Residual	7649.177	84	91.062		
	Total	13794.058	85			

a. Dependent Variable: Algebra Course Grade

b. Predictors: (Constant), Further Mathematics Grade

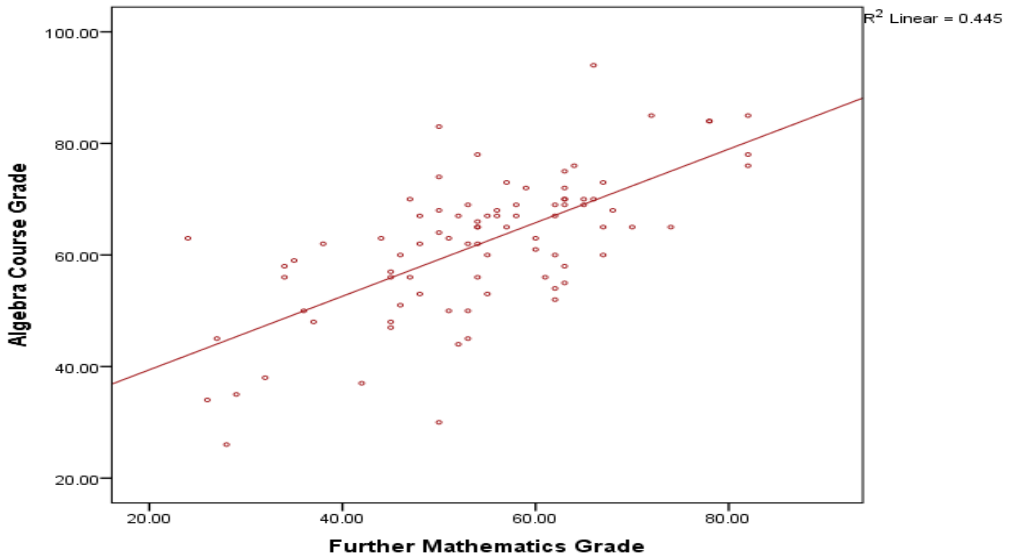
D. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	26.234	4.486		5.848	.000	17.313	35.156
	FMG	.659	.080	.667	8.215	.000	.500	.819

a. Dependent Variable: Algebra Course Grade

The table 2 above showed the regression analysis on the relationship between students' Further Mathematics content coverage in secondary school and their academic performance at university first year Algebra Course. Part A of table 2 showed that students performed better in Algebra course (Mean=62.10, Std. Dev. =12.74) than in Further mathematics (Mean=54.41, Std. Dev.=12.90). Part B of table 2 also showed that the relationship that exist between Algebra Course performance and Further Mathematics performance of first year students is 44.5% (0.445x100) by the R-squared value. Similarly, Part C showed that a significant relationship exist between the variables (Algebra Course performance and Further Mathematics performance) $F_{1,84}= 67.480$, $P<0.000$. Hence, the null hypothesis one was rejected and the alternative retained at 0.05 level of significance. The Part D showed under the column labeled unstandardized coefficients (B) showed that the relationship between the variables Algebra Course Grade and Further Mathematics Grade) can be represented in the equation 26.234+0.659 (Algebra Course Grade). Also, under column labeled-t showed that Algebra Course Grade was significantly contributed to Further Mathematics Grade (8.215) therefore confirmed the significance of ANOVA ratio (F-ratio), Sig.<0.000.

The scatter plot below further shows the linear relationship that exist between Algebra Course performance and Further Mathematics performance.



Relationship between existing between Algebra Course Grade and Further Mathematics Grade

Research Question 3: What is the relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Calculus course?

HO2: There is no significant relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Calculus course.

Table 3. Summary of regression analysis on the relationship between students' Further Mathematics content coverage and their academic performance in university first year calculus course

A. Descriptive Statistics

	Mean	Std. Deviation	N
CCG	57.7209	13.06423	86
FMG	54.4070	12.89631	86

CCG: Calculus Course Grade

FMG: Further Mathematics Grade

B. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.391[a]	.153	.143	12.09621

a. Predictors: (Constant), Further Mathematics Grade

C. ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2216.562	1	2216.562	15.149	.000[b]
	Residual	12290.740	84	146.318		
	Total	14507.302	85			

a. Dependent Variable: Calculus Course Grade

b. Predictors: (Constant), Further Mathematics Grade

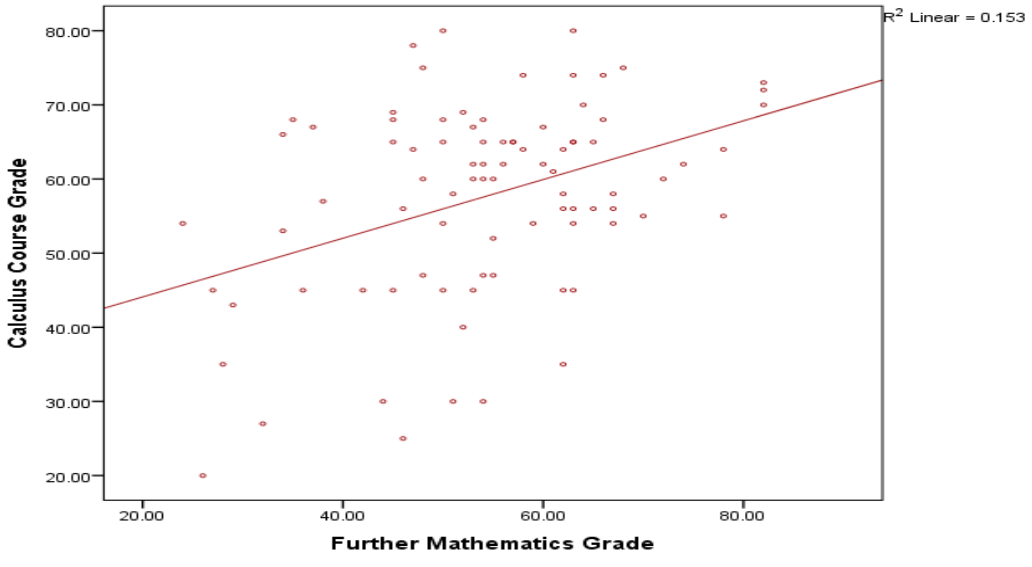
D. Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.	95.0% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	36.177	5.687		6.362	.000	24.869	47.486
	FMG	.396	.102	.391	3.892	.000	.194	.598

a. Dependent Variable: Calculus Course Grade

Table 3 showed the regression analysis on the relationship between students' Further Mathematics content coverage in secondary school and their academic performance in university first year Calculus course. Part A of table 4 revealed that students performed better in Calculus course (M=57.72, Std=13.06) than in Further Mathematics (M=54.41, Std=12.90). Part B of the same table 4 showed that the relationship that exist between Calculus Course Grade and Further Mathematics Grade is 15.3% (0.153x100) by the R-squared value. Similarly, Part C showed that there is a significant relationship between the variables (Calculus Course Grade and Further Mathematics Grade) F1,84= 15.149, P<0.000. Hence, the null hypothesis two was also rejected and the alternative hypothesis retained at 0.05 level of significance. The Part D showed under the column labeled unstandardized coefficients (B) showed that the relationship between the variables Calculus Course Grade and Further Mathematics Grade can be represented in the equation 36.177+0.396(Calculus Course Grade). Also, under the column labeled t showed that Calculus Course Grade was significantly contributed to Further Mathematics Grade (3.892) therefore confirmed the significance of ANOVA ratio (F-ratio), Sig.<0.000.

The chart below further shows the linear relationship between existing between Calculus Course Grade and Further Mathematics Grade.



Relationship between existing between Calculus Course Grade and Further Mathematics Grade

3. Discussion of Findings

Further Mathematics Content Coverage in Secondary School

The results in Table 1 showed that students covered only 8 (sets, Indices, Logarithms, Surds, Trigonometric ratios of special angles, roots of quadratic equations, matrices and determinants) Further Mathematics topics out of the 25 topics that were listed in FM3C. This implies that students do not cover the content of the Further Mathematics to a high extent before entering the University to study Mathematics course or any of its application course such as Engineering, Science related courses or Economics. This finding is in agreement Babatunde (2014) who found out that students hardly cover the contents of Further mathematics before sitting for their secondary school terminal external examination. Table 1 also revealed that the coverage of Further Mathematics content was tilted towards Algebra than Calculus. Mathematics teachers covered many basic topics that appear in both General Mathematics and FM curricula. The more advanced contents were not covered. This could be as a result of their qualification or level of content knowledge in the subject.

Relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Algebra course

Table 2 revealed that the correlation that exist between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Algebra course is positive and high. This is in line with Akajaike (2013) found out that there is a positive high correlation between students Further Mathematics content coverage and their performance in Engineering. The finding implies that the extent of content coverage in Further Mathematics coverage is crucial to the performance of students in University first year Algebra course. This means that a high content coverage in FM leads to a high performance in University first year Algebra course and a low content coverage leads to a low performance in University first year Algebra course. When HO1 was subjected to hypothesis test at 0.05 significant level, it was found that there is a significant relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Algebra course.

Relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Calculus cours

Table 3 revealed that the correlation that exist between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Calculus course is positive and high. This is in agreement with Akajaike (2013) found out that there is a positive high correlation between students Further Mathematics content coverage and their performance in Engineering and Udom (2014) who found out that there was a significant relationship between students Further Mathematics result in West African Senior Secondary Certificate Examination (WASSCE) and their performance in University Mathematics and its application courses. The finding implies that the extent of content coverage in Further Mathematics coverage is plays a crucial role in the performance of students in University first year Calculus course. This means that a high content coverage in FM leads to a high performance in University first year Algebra course and a low content coverage leads to a low performance in University first year Calculus course. When HO2 was subjected to hypothesis test at 0.05 significant level, it was found that there is a significant relationship between students' Further Mathematics content coverage in secondary school and their academic performance in University first year Calculus course.

4. Conclusions

This study concluded that the content coverage of Further Mathematics in secondary school is of low extent and that there is a positive strong correlation between Further Mathematics content coverage and the Mathematics students' academic performance in University first year foundation courses (Algebra and Calculus).

5. Recommendations

Based on the findings of this study, the following recommendations were made.

1. Mathematics teachers should endeavour to attain an indepth and high coverage of Further Mathematics content during classroom instruction.
2. Algebra and Calculus lecturers in Universities should always administer a diagnostic test to ascertain the level of advance Mathematics knowledge that the first year Mathematics students possess.
3. Students should be engaged in career lectures that will expose them to the subjects that are pre requisite for the choice of any career in life.

REFERENCES

[1] Abamba, T. (2012). *Elements of educational management.* Lagos: Flamingo Printing Press.

[2] Akajaike, V. (2013). Effect of Further Mathematics content coverage on students' performance in Engineering course. *International Journal of Educational Research Promotion, 5(3), 114-129*.

[3] Babatunde, B. (2014). Effect of Further Mathematics content coverage in secondary schools and students performance in science subjects in Kwara State. *Journal of Educational Issue & Development, 7(2), 73-85.*

[4] Gbamibole, A.A. (2013). *The effective teaching of Mathematics in schools*. Jalingo: Yul-Rose Publishers.

[5] Jalade, Z. C. (2016). *Students counselling on career choice.* Port Harcourt: Golden Pen Publishers.

[6] Lyakhova, S. & Neate, A. (2018). Further Mathematics, students choice and transition to university: Part 1-Mathematics degree. Retrieved on 21/11/2018 from https://doi.org/10.1093/teamat/hry013.

[7] Nigerian Educational Research and Development Council (2012). *Further Mathematics curriculum.* Abuja: NERDC Press.

[8] Odili, G.A. & Asuru, V.A. (2011). Impact evaluation of Further Mathematics curriculum in Nigeria. *Educational Research and Reviews, 6(20), 997-1004*. Retrieved on 13/10/2018 from https://academicjournals.org.

[9] Onwudire, E.B. (2015). Mathematics and nation building: What is the connect? Proceeding of the 4th National Conference of Association of Computational minds, 217-225.

[10] Udom, D.G. (2015). Correlation between students' further mathematics grades in West African Senior School Certificate Examination and undergraduate Physics course. Journal of Science Education and Technology, 8, 49-64.

[11] WAEC Chief Examiners Report (2013).

[12] WAEC Chief Examiners Report (2014).

[13] WAEC Chief Examiners Report (2016).

[14] WAEC Chief Examiners Report (2017).