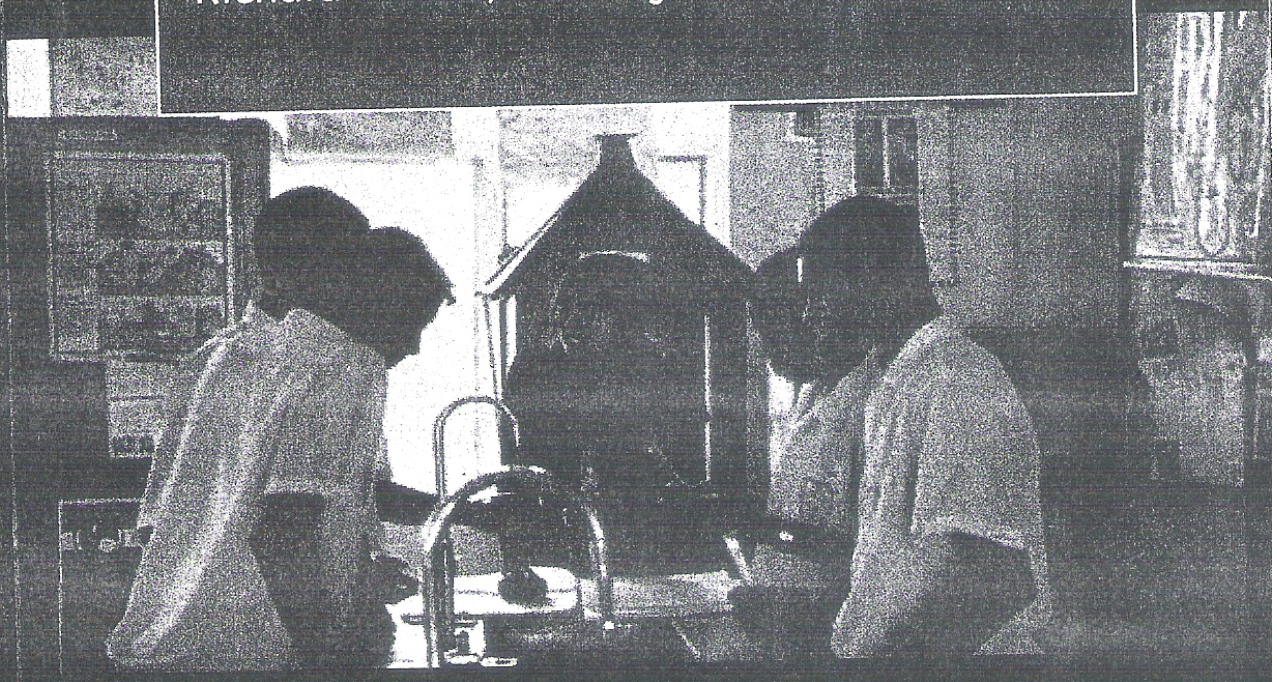
Science Education In Context

An International Examination of the Influence of Context on Science Curricula Development and Implementation

Richard K. Coll, Neil Taylor



Sense

A GLIMPSE INTO MATHEMATICS CURRICULUM DEVELOPMENT AND IMPLEMENTATION IN NIGERIAN PRIMARY AND SECONDARY SCHOOLS

HISTORICAL ANTECEDENTS

The development of mathematics education as a discipline is affected by many factors. The national policy of the system of instruction plays a major part as well as the history of the country and the academic world (Furinghetti, 2006). An historical account of mathematics education and mathematics curriculum development in Nigeria is sprinkled throughout the publications of mathematics education and research (Fajemidagba, 1991). According to Fajemidagba (1991), In Nigeria the formal teaching of mathematics started with arithmetic, a component of mathematics, at the primary and post primary schools. Evans Brothers Limited's early in-roads into mathematics education in Nigeria came from the inspiration of the colonial government at the time. A study of Nigerian's educational development in the 1940s, inspired Evans UK to send an emissary to Nigeria in 1945/46 in the person of Dr D.H. Larcombe who later returned to recommend the publication of a primary arithmetic book (Akinsola, 1999). Arithmetic was compulsory for every primary school student, and had to be passed before a student could obtain the Primary School Leaving Certificate. The same condition held for the teacher training colleges - either Grade 2 or Grade 3. At the secondary school level, mathematics was taught in compartments: algebra, arithmetic, and geometry with trigonometry. The schools were largely guided by the examination syllabus at the Cambridge local syndicate, the West African Examinations Councils (WAEC), or the University London General Certificate of Education Ordinary or Advanced Level. Later in 1968, the WAEC published three alternative syllabi for mathematics at the Ordinary level: alternatives A, B and C. Alternative A contained arithmetic process, algebra, absolute geometry and trigonometry. Alternative B contained the same items as Alternative A, but with the additional topic of coordinate geometry. Alternatives A and B were for average mathematically capable students studying mathematics. The Alternative C syllabus contained topics in commercial subjects for commercial students (Badmus, 1997). By interpretation, the mathematics curriculum did not cater for the interest towards science and technology of the mathematically inclined students. These examination syllabi were invariably turned into teaching syllabi by mathematics teachers.

The major cause of the changes in school mathematics curricula and programs was the launching of the Sputnik, the first earth satellite in space, in November 1957 by the Russians. The event, according to Griffiths and Howson (1974), had

Richard K. Coll, Neil Taylor (eds.), Science Education in Context: An International Examination of the Influence of Context on Science Curricula Development and Implementation, 251–260.
© 2008 Sense Publishers. All rights reserved.

an enormous effect on American complacency about their superiority in engineering capability compared with the Russians. The result of that doubt was a series of hot debates and arguments on the suitability or otherwise of the school mathematics and science curricula. These occurrences were regarded as the 'issues and forces' behind the reformation of school mathematics curricula contents, which also affected various reforms in the school mathematics program in Nigeria. This was the 'revision syndrome' which swept the world (Fajemidagba, 1991).

Elementary mathematics was introduced to primary schools in Nigeria in order to replace arithmetic and this was taken on board by teacher training colleges. The attempt was to produce a primary school teacher who could teach elementary mathematics, and in-service programs were organized for practicing teachers for the purpose of retaining them. As a continuation of the innovation, entrance examinations for secondary schools, which used to contain arithmetic and English, were changed to mathematics and general knowledge, which included some mathematics concepts and English. The national Common Entrance Examination took a lead in the changes. Moreover, the trend forced nearly all primary schools in Nigeria to commence the teaching of mathematics.

The introduction of 'modern mathematics' to secondary school students marked the beginning of the teaching of mathematics as a composite or integrated body of knowledge, rather than as a subject compartmentalized into arithmetic, algebra and geometry with trigonometry, that were separately taught to students previously. The introduction of modern mathematics was the aftermath of the wave of changes in school mathematics that traversed industrialized nations. Ohuche (1978) reported the outcomes of an international conference on Science in the Advancement of New States in Retrovoth, Israel in July 1960. This conference contained some recommendations for innovations in school mathematics for African states. The recommendations led to the establishment of the African Mathematics Programme (AMP) known as 'Entebbe Mathematics', because the program was developed in Entebbe in Uganda. The program was eventually called the African Mathematics Programme because its initiators had in mind mathematical content which would centre on the needs of Africans, and which would correlate with African cultural values and traditions without any prejudices against modern education.

The Entebbe Mathematics program started in 1962 with three macro-goals:

- to prepare and publish instructional materials in mathematics for use in schools, teachers' colleges and in-service institutions in African States;
- to trial - test the developed materials in schools and teachers' colleges; and
- to train teachers for the proper use of the developed instructional materials. (Osibodu, 1988)

Thus, the goals seem to parallel the Research, Development and Dissemination (RD&D) paradigm. That is, those involved in the project were assigned to 'fishing out' local materials that would meet the mathematics needs of African children,

then to develop these materials to meet the mathematical needs of the African child.

Mr. Hugh P. Bradely was the director of the AMP and the Education Development Center; Newton, Massachusetts housed its administration. This was the case because the US government provided the bulk of the funding for the program. African and American mathematicians were employed at various workshops to develop mathematics courses and materials that would go into the program. The mathematicians were engaged as consultants. Some of them lectured at various institutes organized for the training of African mathematics teachers on how to use the mathematics materials. Eleven training institutes were established in Ethiopia, Ghana, Liberia, Malawi, Nigeria, Uganda, Sierra Leone and Tanzania, and a four-week meeting was scheduled for the development of textbooks. Three textbooks were produced for use in secondary schools, Advanced Mathematics 1, 2 and 3. These books were adopted for mathematics teaching and learning in African countries that accepted the African Mathematics Programme. In addition to the secondary school textbooks, a series of six textbooks were developed for primary schools. The mathematics concepts treated in the books include the structure of arithmetic, foundations of geometry, measurement, functions and probability, the number line and fractions.

Nigeria, according to Ohuche, (1978) participated actively in every facet of the African Mathematics Programme; however, the only successfully implemented project under the auspices of the AMP was the Lagos State Primary School Mathematics Experiment. The project started in January 1964 under the directorship of Professor Alele-Williams. Other states in Nigeria did not accept the modernization of the mathematics curriculum, dubbed 'modern mathematics' at the primary school level. According to Williams, (1974) the Lagos State Ministry of Education accepted the introduction of innovations into the primary school mathematics curriculum. Thus, the original Entebbe primary mathematics textbooks were adopted for use in Lagos state primary schools.

As a part of the project, primary school teachers in Lagos state were retrained through in-service activities. This was in tune with the objectives of the African Mathematics Programme. The actual use of the mathematics materials did not commence until 1971. However, traditional textbooks (e.g., the Larcombe Arithmetic Series) were allowed to compete with the Entebbe Primary Mathematics series, and many teachers did not understand the objectives and the subject-matter content of the series. This was probably a reflection of the inadequacies in the mathematical training received by primary school teachers. The majority of the primary school teachers studied arithmetic in the course of their training, so they could not be described as specialists in mathematics teaching at the primary school level. It is of interest to note that the funding agencies were the United States Agency for International Development (USAID) and the Ford Foundation.

In 1970, the West African Regional Mathematics Programme (WARMP) was formed by West African English speaking countries in order to cater for the mathematical needs of the Anglophone West African Countries. It was an off-shoot

of the AMP. Unfortunately, Nigeria declined to participate in the Programme (Ohuche, 1978). Rather, Nigeria established the Nigerian Educational Research Council (now Nigeria Educational Research and Development Council (NERDC)) in 1969. This body was given the responsibility of charting a new course in the modernization of the school mathematics curriculum in Nigeria. Before dealing with the activities of the NERDC, a brief historical account of the Joint School Project is given. The textbooks developed from the project were recommended for the teaching of modern mathematics in Nigeria.

Another dimension to the modernization of the mathematics curriculum was the introduction of Joint School Project (JSP) textbooks into Nigeria. The JSP was started in February 1964 by eight teachers from three secondary schools in Ghana. Eight teachers worked as a subcommittee of the Mathematical Association of Ghana, with the initial work on the project commencing at Achimota School, Ghana. The organizational agencies were the University of Ghana and the Ministry of Education, Accra, Ghana. The funding agencies were the Nuffield Foundation, the Center for Curriculum Renewal and Development Overseas, London, the Guinness Award Scheme, and the World Confederation of Organization of the Teaching Profession. The macro goals of the project were:

- to produce a 'new mathematics' course for secondary schools on practical work to make up for a lack of opportunity for such experience in students' cultural and educational background;
- to make the course relevant to the environment, future needs of students, and to encourage learning by understanding rather than by rote;
- to give an intuitive development of the course, since experience had shown that an over-emphasis on logic kills all interest and hinders progress; and
- to modernize mathematics topics in order to achieve the objectives above.

The JSP course was at two levels: basic, for those students who would do no mathematics after the Ordinary level; and special, for those who would specialize in science subjects after the Ordinary level. The project further differed from similar projects because emphasis was placed on how mathematics arises naturally in the environment, and how it can be applied in various situations rather than placing emphasis on the logical structure of mathematics itself. The originators of the project felt that this approach would prove to be much more valuable for the average student in Ghana. A set of textbooks for both students and teachers was produced by the originators of projects. Several secondary schools in Nigeria adopted the textbooks for mathematics teaching and learning, and the WAEC started examining students on a syllabus based on the project in June, 1969 (for further details of JSP, see Lockard, 1970).

The modern mathematics program, however, did not succeed in Nigeria. Catalogues of criticisms were levied against the programs. The contents of the modern mathematics curriculum were meant for potential mathematicians, not for the consumers of mathematical ideas who form the bulk of the student population.

Also, parents found the content difficult to understand, and thus could not help their children. Finally, parents and teachers pointed out that the textbooks were too 'wordy' for lower secondary school students.

It is very difficult to really pin down a logical argument against the modernization of mathematics in Nigeria. It is well understood and accepted that there were a small number of mathematics teachers at the secondary school level and majority of the teachers were not adequately trained to teach the new mathematics. Also, it could be conjectured that a majority of the trained mathematics teachers lacked in-depth knowledge of mathematics content, and the quantity of mathematics learned at the various training colleges might not be adequate for an in-depth understanding of the content of the new mathematics curriculum. The unification of mathematical ideas has been a serious issue for mathematics educators and mathematicians. Attempts are made to postulate a unifying theme for mathematics at the primary and secondary school levels. The new mathematics introduced either through the Entebbe Project or the JSP project seems to have used set theory as the 'unifying concept'. Other researchers in mathematics have also proposed the 'function' as the unifying theme for secondary school mathematics. By and large, no unified mathematics idea has been provided for students. Undoubtedly, researchers in mathematics education and mathematics will continue to work on the formulation of a unifying theme for mathematics teaching in schools.

The controversy surrounding the modern mathematics prompted the Federal Government of Nigeria to organize a conference, held in Benin City in December, 1977. Mathematics educators and mathematicians were invited as participants at the conference. However, it was at the conference that a ban on modern mathematics was announced by the Government. The announcement was a shock to many participants, because it was contrary to their expectations.

After the announcement, the Nigerian Education Research and Development Council (NERDC) was mandated to produce appropriate mathematics curricula for the Nigerian children. It was stipulated that the curricula should take cognizance of the needs of the nation and those of the children. As a sequel to this, a workshop was organized at the University of Ibadan in February, 1977. The workshop's focus was on the study of the problems facing the teaching of mathematics in Nigerian schools and colleges. It was at this workshop that proposals were made for the development of a set of new mathematics curricula for schools and colleges in Nigeria. This set was intended to adequately address the provisions contained in the New National Policy on Education. In the policy, it is stipulated that a 6-3-3-4 system of education would be embarked upon in Nigeria. In the system, mathematics was to be a core subject for primary school pupils, junior and senior secondary school students.

Several workshops were organized by the NERDC in order to produce a set of mathematics curricula that met the requirements of the 6-3-3-4 system of education. A mathematics curriculum was developed for primary schools, one for junior secondary schools and two (General Mathematics & Further Mathematics) for senior secondary schools. The Further Mathematics curriculum is meant for

those who have the intention of studying mathematics beyond the senior secondary school level or those who intend to study mathematics-related disciplines, for example, physics, chemistry, engineering, architecture, and the like. Another mathematics curriculum was developed for the teacher training colleges.

These mathematics curricula are in operation in every school and teachers' Grade 2 in Nigeria. Attempts are being made to produce textbooks based on the curricula. The NERDC has produced a set of six textbooks for the primary schools, covering Primary 1 through Primary 6. Also the Mathematical Association of Nigeria, (MAN) as well as Science Teacher Association of Nigeria (STAN), has produced a mathematics textbook for junior Secondary Year 1 up to Senior Secondary 3. Other government agencies and publishing houses have also produced mathematics textbooks based on the new set of mathematics curricula. However, no serious evaluation has been performed on the curricula and the accompanying mathematics textbooks. This is a challenge to mathematics educators and mathematicians.

MATHEMATICS CURRICULUM TRANSITION (1970-1977)

Modern mathematics spread its tentacles faster among the primary schools though with varying times of commencement in the different parts of the country. It started in Lagos State primary schools in 1971, while other states of the federation started in 1974. The political undertones experienced during that period include an acute shortage of personnel to implement the curriculum, lack of suitable textbooks, multiplicity of courses and poor level of information dissemination by existing educational bodies. The evidence was glaring that the northern states had not trained teachers to handle the curriculum. In 1973, a modern mathematics curriculum was drawn up the secondary schools intended to make mathematics more meaningful, and it used set theory to make mathematics concepts meaningful - but few teachers could do this. This was the political undertone to the implementation of modern mathematics curriculum. The efforts of the NERDC, Mathematical Association of Nigeria (MAN), Institutes of Education of Universities and West African Examination Council made the nation realize the flaws in the scope and contents of modern mathematics, which some educators believed were the handiwork of some collaborator with colonial powers to re-enslave Nigeria via her school system. The poor mathematics results in the West African School Certificate Examination (WASCE) in 1974 were part of the evidence that there was problem with modern mathematics. As a result of consistent failures in mathematics, especially in modern mathematics, there was a general tension among educationists, parents and other stakeholders as to the desirability of continuing with the then mathematics syllabus. This made different mathematicians like Professors Iya Abubakar, Chike Obi, Adegoke Olubunmo, James Ezeilo and their contemporaries call for the cancellation of modern mathematics. The activities of some those mathematicians led to the formation of a different mathematics movement to protect the national curriculum from further degenerating into backwardness compared with other nations. These movements

include African Mathematics Union's Commission on Women in Mathematics in Africa (AMUCWMA) founded by Grace Alele Williams, and War Against Poor Achievement in Mathematics (WARPAM). It was obvious that the non-appropriation of the modern mathematics curriculum also slowed down the pace of science and technology. This affected the teacher training curriculum that was prepared to cater for the teeming pupils of the primary schools. Furthermore, the government, nursing an ambition for universal primary education (UPE) to start in 1976, saw the need to arrest students' mass failure in mathematics in order to put the nation on the threshold of science and technology.

MATHEMATICS CURRICULUM TRANSITION (1977 TO 2007)

The 1977 Benin conference on modern mathematics marked a turning point for the mathematics curriculum. While the participants were deliberating on the way out of correcting the problems engendered by modern mathematics, the then Federal Commissioner of Education, Dr A.A. Alli, announced that the Government was no longer interested in the continuation of the subject. This singular pronouncement shocked the stakeholders. At the conference, NERDC was mandated to come up with a proposal to prepare more relevant mathematics curricula for all levels on sound footing. This body organized a series of workshops (among which was a national critique workshop on mathematics curriculum at Onitsha in March 1978 under the eminent mathematician, Professor J.O.C. Ezeilo) which produced a primary school mathematics curriculum, primary teacher education mathematics curriculum and secondary school mathematics curriculum. Table 1 shows the nature of mathematics curriculum in secondary schools, testifying to the scope and contents of mathematics at that level.

Unlike the old secondary school mathematics curriculum that comprised arithmetic processes, algebra, geometry and trigonometry, the new integrated mathematics curriculum split the contents areas of the curriculum into major topics and aligned it with the group of students at which these topics were aimed. This clarified the confusion which the old curriculum brought about as there had been no such specification to help the then teachers understand how to handle the topics, even when few of them know the topics. Also, there was no other mathematics specifically prepared for the talented students who would pursue mathematics and related subjects further in life. This might be one of the reasons for the proliferation of liberal arts courses like classics, history, and law at the expense of science and technology. The new mathematics curriculum provided separate mathematics, and further mathematics curricula as shown in Table 2, in the upper three years of the secondary school levels for mathematically-inclined students who might wish to pursue careers in the areas of science and technology. More scientific and technological mathematical topics were introduced to ensure that the national goal of self reliance in the area of science and technology that had might be realized.

Table 1. Nature of mathematics curriculum in secondary schools

S/N	*Major Topics*	*Junior School Topics*	*Senior School Topics*
1	Numbers and Numeration	Number systems, functions, decimals, factorization, proportion and approximation	Indices and logarithms, exponents, set theory and progression
2	Algebraic processes	Mathematical statements, simple equations and Inequalities variables	Quadratic equations, simultaneous equations, and Inequalities
3	Geometry and Measurement	Basic properties of 2-and 3-dimensional-shapes, properties of angles, scales and the elementary trigonometry-ratios	Geometrical constructions, basic Euclid theorems, Advanced measurement in 2-and 3-dimensional shapes
4	Everyday Statistics	Data collection techniques and graphical representation, frequency tables, measures of central tendency (mean, median and mode), elementary ideas of probability	Construction and interpretation of statistical representation, histograms, bar graphs and charts, group data analysis, measures of central tendency and dispersion in a continuous case and data interpretation
5	Trigonometry		Further treatment of angles and compound angles, equation involving trigonometry identity
6	Probability		Experimental and theoretical probability, conditional and discrete cases

IMPLEMENTATION

The Federal Government of Nigeria introduced the 6-3-3-4 system of education in 1979. This development made it necessary to have two separate mathematics curricula for use in secondary schools (junior and senior). The implementation of the senior secondary mathematics curriculum was scheduled to be launched with the first graduates of the junior secondary school students in 1985/86 school year. Unfortunately, the implementation of the new system of education could not commence as scheduled in all states during the second republic (1979-1993). Only a few states took the giant step to implement the new policy even though education is a part of the nation's constitution. However, with the coming of military administration at the end of 1983, considerable progress was made in the implementation of the new policy and all the states of the federation embraced the

policy (Jahun & Korau, 1991). This new dispensation was made possible simply because the military run a unitary kind of government.

The earlier curriculum for school mathematics was developed without much involvement of the classroom teachers. This is contrary to the suggestion of many curriculum specialists (Hawes, 1979). Proper implementation of the mathematics curriculum at any level of education depends largely on the classroom teachers attitudes, ingenuity, creativity and devotion to the teaching of mathematics (Gould 1960). In a study conducted by Jahun and Korau (1991) on mathematics teachers perception of the new curriculum, it was found that there was a sharp difference between the curriculum innovations and the way the mathematics teacher perceived the mathematics curriculum. Probably this was what the organizer of th National Curriculum Review Conference of September, 1991 had in mind when various stakeholders (including teachers and teacher unions) were invited to participate in a review of the various school subjects, including mathematics. The outcomes of this review led to new mathematics curricula which as of 2007 are in operation at the primary, junior and senior secondary schools.

Table 2. Nature of further mathematics curriculum in the secondary schools

S/N	*Major Topics*	*SS I*	*SS II*	*SS III*
1	Pure Mathematics	Identification and Measurement in 2 and 3 dimensions, Construction, Formal Geometric proofs, Trigonometric Ratios, Indices and logarithms, Calculating and Processing Devices, Algebraic Equations, Polynomials, Partial Fractions, Linear Inequalities and Logic	2-dimensional Rectangular Cartesian Coordinates, Differentiation, Logic, Sets, Mapping, Operations, Calculating and Processing Devices, Geometry and Trigonometry	Mensuration in 3 dimensions, Analysis, Functions, Calculating and Processing Devices, Matrices and Determinants
2	Mechanics	Vectors and Dynamics	Vector Geometry, Dynamics	Statistics
3	Statistics	Measures of Location and Dispersion	Correlation, probability and, Permutations and Combinations	Probability Dimensions, Scatter Diagrams

Source: National Curriculum for SSS by Federal Ministry of Education (1985)

REFERENCES AND BIBLIOGRAPHY

Akinsola, M.K. (1999). Mathematics curriculum in the primary and secondary schools. In A. Dada, (Ed.), *The teacher and the curriculum* (pp. 124-134). Ibadan, Nigeria: Tejama General Enterprises.

Badmus, G.A. (1997). *Mathematics education in Nigeria.* Lagos, Nigeria: Nigerian Academy of Education.

Fajemidagba, O. (1991).Trends in mathematics education in Nigeria: Issues and problems. *Abacus: The Journal of Mathematical Association of Nigeria, 21*(1), 139-153.

Furinghetti, F. (2006). Not out of the blue: Historical roots of mathematics education in Italy. *The Montana Mathematics Enthusiast, 3*(1), 99-103.

Gould, S.B. (1960). Curriculum implementation. In E.C. Short & G.D. Marconnit (Eds.), *Contemporary thought on public school curriculum* (pp. 124-138). Dubuque, WMC: Brown.

Griffiths, H.B., & Howson, A.G. (1974). *Mathematics society and curricula.* London: Cambridge University Press.

Hawes, H. (1979). *Curriculum and reality in African primary schools*. Essex, UK: Longman.

Jahun, I.U., & Korau, Y. (1991). Teachers' perceptions of the new senior secondary school mathematics curriculum. *ABACUS: The Journal of Mathematical Association of Nigeria, 21*(1), 58-69

Lockard, J.D. (1970). *Seventh report of the international clearing house on science and mathematics curricular developments.* A Joint Project of American Association for the Advancement of Science and Science Teaching Centre, University of Maryland.

Ohuche, R.O. (1978). Change in mathematics education since the late 1950s: Ideas and realization, Nigeria. *Educational Studies in Mathematics, 9*, 271-281.

Osibodu, B.M. (1988). Mathematics at Primary Level. *ABACUS: The Journal of Mathematical Association of Nigeria, 18*(1), 13-20

Williams, G.A. (1974). Dynamics of curriculum change in Mathematics: Lagos State Modern Project. *West African Journal of Education, 27*(21), 231-240.

AFFLIATIONS

Mojeed K. Akinsola
Department of Primary Education
Faculty of Education
University of Botswana
Botswana

Adetunji A. Olaoye
Department of Curriculum Studies
Lagos State University
Nigeria