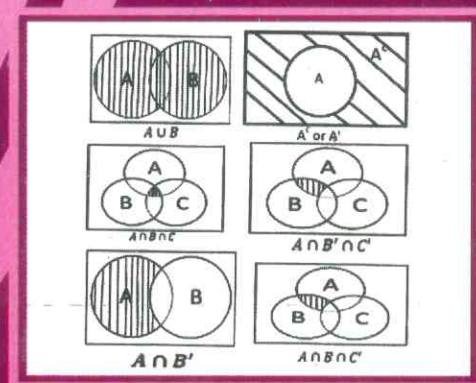


ENHANCING MATHEMATICS EDUCATION IN NIGERIA

A Festschrift in Honour of
Professor Michael
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CHAPTER TWENTY ONE

IMPROVEMENT STRATEGIES FOR CURRICULUM DEVELOPMENT AND CURRICULUM DELIVERY OF SECONDARY SCHOOL MATHEMATICS EDUCATION

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Introduction

Curriculum is a term which has its root from Latin word. It literally means "race course" which suggests combination of time and course. Its evolution as a field of study began in 1890 as thinkers in the field of education were interested in exploring the field for centuries. The fundamental purpose of curriculum is to coherently integrate learning items and experiences needed for human development (personal, academic or professional) into a structured series that is learnable and teachable within specified period of time. The curriculum is therefore the officially prescribed documents that define what pupils should learn and what teachers should teach in a subject within a school system. It is the prescription of what students should learn and teacher should teach.

For Mathematics as a subject, the curriculum bridges the gap between the teachers and learners, which according to Fajemidagba (1984) is expected to make contact with at least three areas of reality. These are:

- i) the growing body of knowledge in the field itself;
- ii) the specific mathematical needs of sciences, technology and profession; and,
- iii) the minimal understanding of Mathematics an ordinary person must have to live comfortably in a technical culture.

Like every other discipline, Mathematics has its own structure and nature. The implication is that the Mathematics curriculum must grow with times in design, development and delivery. That is, much more needs to be known about the mental functioning of children who are expected to be taken through the curriculum, and about the teachers who are expected to operate it, at least to cope with abstract thinking Mathematics demands.

Mathematics as a discipline is a collective name for geometry, arithmetic, algebra and certain sciences involving geometry reasoning such as astronomy and optics. It can be seen as a body of knowledge, a collection of techniques and methods, the products of human activity, and even the activity itself (problem solving). In other words, it is a creation of the human mind which is concerned primarily with ideas, processes and reasoning. Before now, Mathematics has been in nature. The idea of counting by our

forefathers, records keeping, scrolls, etc. is indications of old nature of Mathematics. However, mathematical activity has been vigorously pursued with corresponding significant changes introduced by the Greek people around the East-Mediterranean during 200- 500 BC. The Greek mathematical tradition lasted for several further centuries, notably in Alexandria, and ranged from astronomical and geographical work, exemplified by Ptolemy, to the arithmetical investigations of Diophantus who raised the solving of number-problems to a new height.

With the sequential remarkable works by mathematician of earlier times, recent efforts and researches from stakeholders, there is an indication that teaching and learning of Mathematics is shifting from a product to a process with emphasis on problem solving. Fajemidagba (1986 & 1991) pointed out that the reform in Mathematics started in early 1930's and extended to 1960's. The author viewed Mathematics as highly structured discipline that has a conceptual and syntactic structure, which implies that the need of the society, the content of the subject and the psychological ability of the learner must work harmoniously for effectiveness of the Mathematics curriculum (Olayi, 1990). It is in line with this that Ale (1989) opined that Mathematics remains the most serviceable science subject to all disciplines and fields of human work and study. In this century, it has been applied more diversely than ever before. From the traditional applications in physical sciences to new applications, its usefulness justifies its core position in the Nigeria National Policy on Education (NPE, 2004; 2013). The aims and objectives of Mathematics as contained in the present school general Mathematics curriculum are enumerated as follows:

- (i) to develop the ability to recognise and solve problem with related Mathematics knowledge;
- (ii) to develop precise logical and abstract thinking;
- (iii) to develop and encourage creativity;
- (iv) to develop necessary mathematical background for further education;
- (v) to develop computational skills and foster the desire and ability to be accurate to a degree relevant to the problem at hand;
- (vi) to provide necessary mathematical background for further education; and
- (vii) to generate interest in Mathematics and provide a solid foundation for everyday living (FRN, 2004)

Expectedly from the objectives, Mathematics is all about finding solutions to problems and its teaching is therefore of importance to human existence. In essence, the policy intends to make instructions geared towards inculcating values such as respect for the worth and dignity of the individual, faith in man's ability to make rational decision, moral and spiritual principles in inter-personal/and human relation, shared responsibility for the common good of society, promotion of the physical, emotional and psychological development of all children and acquisition of competencies necessary for self-reliance. The curriculum is thus structured or intended to present learners with scientific explorations and targeted development of learners' creativity in this present highly experimental science world. This was reiterated by Okebukola (2002) that

without Mathematics, there is no science; without science, there is no technological development; and that without technology, there would be no modern society. In achieving these, the Nigeria Mathematics curriculum focuses on three keys areas namely: skill, attitude and knowledge. The skill area addresses the use of mathematical language to communicate ideas while attitude is of learners' interest / appreciation of precise and aesthetic aspects of Mathematics. The knowledge area which is concerned about intuitive, deductive and analytical approach is that of contents categorised into six broad themes:

1. *Number and Numeration*: Exponents, logarithm, set notation and progression;
2. *Algebraic processes*: Quadratic equation, simultaneous/linear equation and inequalities;
3. *Geometry and Measurements*: Geometric construction basic Euclidean theories and harder measurements in 2-dimension and 3-dimension shapes;
4. *Trigonometry*: Further treatment of angles;
5. *Probability*: Theoretical and experimental probability; and
6. *Statistics*: Preparation and interpretation of histograms of grouped data, the measure of central tendencies and use of standard deviation in practical problems.

Sequel to this, the objectives of the revised National Mathematics Curriculum for Basic Education (primary basic one to junior secondary school three) as targeted by the duo of Millennium Development Goals (MDGs) for 2015 and the National Economic Empowerment and Development Strategies (NEEDS) also place emphasis on affective domain and quantitative reasoning for the purpose of enhancing achievement in cognitive and psychomotor capabilities of the learners. The objectives include:

- (i) developing the essential elements of problem-solving communication, reasoning and connection within the study of Mathematics; and
- (ii) understanding the major ideas of Mathematics bearing in mind that the world has changed and is still changing since the first National Mathematics Curriculum (NERDC, 2007).

It must therefore be noted that Mathematics is a discipline of thought, inquiry and creativity. It is more than full of enrichment rather essential ingredient in leading students, to the higher level of mathematical thought processes. Like any other subject, determination or preparation of Mathematics curriculum and syllabus is the responsibility of some accredited bodies / agencies. These bodies include – the West African Examinations Council (WAEC), National Examinations Council (NECO), Nigeria Education Research and Development Council (NERDC), State and Federal Ministries of Education, and so on. The curriculum contents are usually arranged under the following subheadings: topics, contents and remarks indicating the scope. Consequently, Fajemidagba (1984) observed that the determination of which curriculum items or categories are to be learned first before other items by students should be the primary concern of curriculum developers as it has constituted a crucial problem. This

implies the pivotal role of curriculum item selection and sequencing for a meaningful learning.

German thinker, Johann Friedrich Herbart (1776-1841) who emphasised the importance of items selection and organisation for meaningful learning outcomes is generally associated with the evolution of curriculum. His first book devoted to the theme of curriculum entitled 'The Curriculum' was published in 1918 by Franklin Bobbitt, and followed by another entitled 'How to make Curriculum' in 1924. From its beginning in 1890 and publication of America Society Year Book on the Foundation and Technique of Curriculum Construction in 1926, issues of curriculum development and reformations have been vigorously pursued in educational movement across the globe.

According to Centre for the Advancement of Teaching and Learning of the University of Western Australia, Curriculum Development (CD) encompasses the design and development of integrated plans for learning, the design of implementation of the plans, and of the evaluation of the plans, their implementation and the outcomes of the learning experience. The main purpose of the process is to translate broad statements of intent into specific plans and actions. The intention is to ensure, as far as possible, alignment between the three states of curriculum: the planned curriculum, the delivered curriculum and the experienced curriculum.

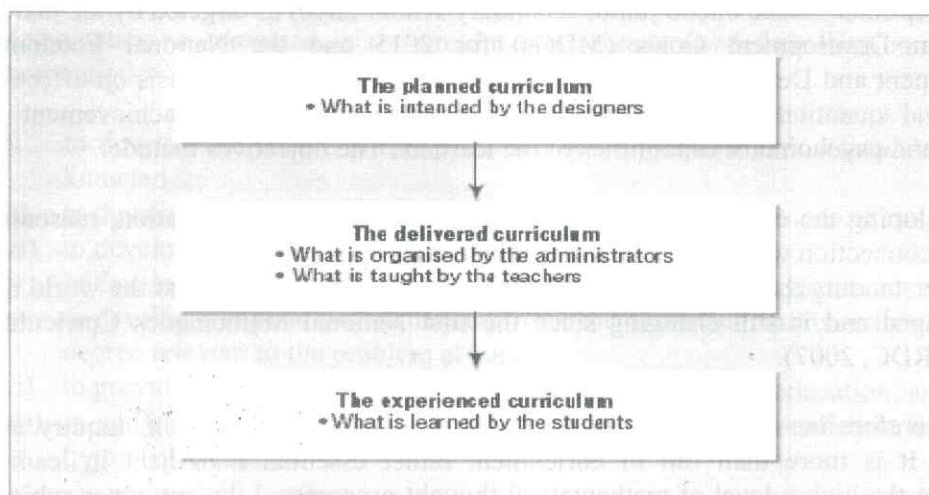


Figure 1: *The three states of the curriculum* (see Prideaux, 2003)

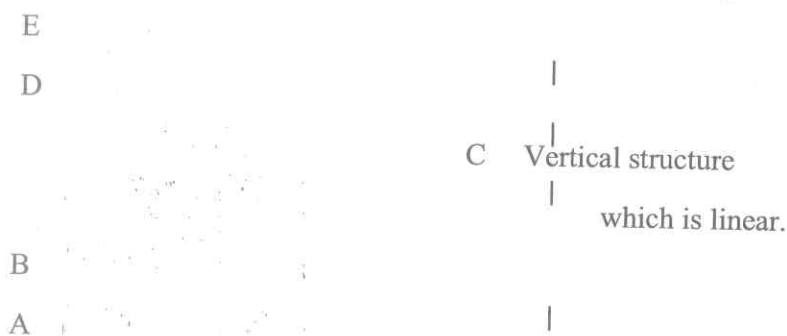
The curriculum design process at course level sets the context for unit design while the unit design, in turn, sets the context for each learning experience. Units need to be designed to come together in structured combinations to form coherent major and minor sequences and courses. Parts of the process especially at the course and unit levels overlap and ideally should occur interactively with course design informing and influencing unit design, and unit design informing and influencing course design. The fundamental purpose of curriculum development is to ensure that students receive integrated, coherent learning experiences that contribute towards their personal,

academic and professional learning and development. The idea of having functional, relevant and suitable school Mathematics curriculum, particularly at the senior secondary school level is thus germane and, has attracted attention of stakeholders at different fora as one of the major, if not only problem of the Nigerian school Mathematics curriculum.

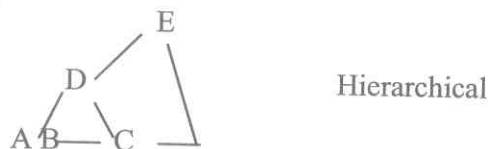
The significance of Mathematics items curriculum item selection and structuring can therefore not be underestimated. As delineated by Fajemidagba (1984) in Akanmu (2017), in selecting items to be included in the Mathematics curriculum, ordering of items for the purpose of validation or further refinement and, mapping items for theoretical and practical purposes, the stages of cognitive functioning of learners should be the focus of attention. This is to essentially help teachers with mixed-ability classes to be able to recognise that the differences in success rates in Mathematics are due to differences in the levels of cognitive functioning of their students. It was therefore concluded that the essence of structuring cannot be over stressed and that, curriculum of the secondary school Mathematics in Nigeria could logically be structured through either synchronic or diachronic process.

By synchronic, we mean concurrent arrangement of items, sub-categories and categories while the diachronic represent arrangement of items or categories at successive levels. For Mathematics, the diachronic approach is considered suitable with adoption of spiral curriculum structure. The diachronic approach according to Wiles and Bondi (2011) has the following results:

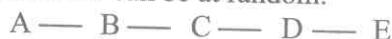
1. Vertical structure in which there is a single best sequence.



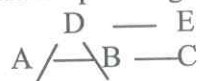
2. Pyramidal hierarchical structures.



3. A flat structure in which order can be at random.

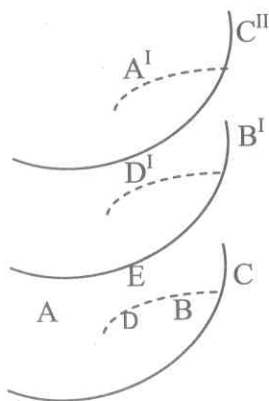


4. Adjunct or mixed structure in which there are hierarchies within categories but a flat relationship among categories.



Adjunct

5. Flat-spiral structures where order is unimportant except for recurrence of topics at successively higher levels of complexity.



Whenever there is no inherent sequence based on pre-requisites, continuity can be enhanced by arranging categories on the basis of some themes e.g. function or groups in algebra.

For our understanding now, the overview of the different structures within diachronic dimension for Mathematics placed flat-spiral structure ahead with respect to sequencing on relational or pre-requisites need of concepts to be taught or learned for the purpose of continuity not coherence which makes Mathematics different in nature and structure compared with other subjects or disciplines. This distinction presents the need to emphasise applications of knowledge for appropriate placement of items within the Mathematics curriculum. In developing Mathematics curriculum therefore, present day Mathematics must solve problems of perception and theoretical approach beyond preparation of students for public examinations. Hence, rather than turning examination syllabi into teaching syllabi leading to promotion of rote learning, learners should be made to see reason for studying Mathematics. The usefulness for meaningful learning and acquisition of mathematical knowledge needed to have successful learners with essential learning skills of literacy, numeracy and information communication and technology, should be clear to Mathematics students.

Effective Strategies for Mathematics Curriculum Delivery and Implications for Sustainable National Development

The Nigerian system of education which is largely being guided by the policy, since the success in the self-rule agitation from British colonial rule (which was said to be narrow in scope and did not meet the hope and aspirations of Nigerians) has changed from 8-6-

2-3; 6-5-2-3; 6-3-3-4, and, recently to 9-3-4 in search of a robust and all-encompassing system. This represents years for primary education, junior secondary education, senior secondary education and college/ polytechnic/university education (higher education). The changing phases, according to Imam (2012) could be attributed to personal idiosyncrasies of the actors, political instability, corruption and lack of political will. The changes leading to curriculum reforms have been informed by three main factors, namely: cultural transmission, environmental adaptation and total personality development. These three factors equally affect Mathematics curriculum in term of delivery and raising scientific literate society. The change of the pre-independence Mathematics education and Mathematics curriculum, and the over flooded nature of the new curriculum with ideas from foreign lands which culminated in ban of the teaching of modern Mathematics in Nigerian schools remain fresh, and till date, accounted largely for form of sketches in our ability to discern the problems and possible solutions to Mathematics teaching and learning in Nigeria.

The Nigeria nation must therefore key into the three broad trends with which present day Mathematics is characterised. The principal broad trends are; (i) variety of applications, (ii) a new unity in the mathematical sciences, and (iii) the ubiquitous presence of the computer (Hilton, 1984). The decision to follow global trend will set the tone for new learning experience. The supporting strategies need to take into cognizance: (i) consistency with stated aims and intended learning outcomes (ii) appropriateness of content and relevancy for our need (iii) availability of resources and possible constraints, and (iv) the learning environment.

The aims and objectives of Mathematics curriculum are clear and unambiguous, one of which is to develop and encourage creativity. This can be rooted in variety of applications. Polya (1962) defined mathematical knowledge as information and know-how. Of the two, he regarded know-how as the most important, defining it as the ability to solve problems requiring independence, judgment, originality, and creativity. A gifted student of Mathematics possesses all of these characteristics and needs the opportunity to use them when solving challenging problems. Deliberate intention, on the part of curriculum developer and Mathematics teachers, should therefore be to encourage the acquisition of general scientific skills relating to the systematic assembly, critical analysis, interpretation and discussion of factual information and data to stimulate approach to the major forces instrumental in the shaping of society and culture in Nigeria. When students begin to explore the structure of Mathematics, they begin to explore the beauty of the domain and develop a sense of Mathematics. Rather than closed problems with a single solution, students should be provided with open-ended problems with a range of alternative-solution. Encouraging learner to reach beyond the familiar and probe deeper into the relationships and structures of a problem is the essence of teaching Mathematics creatively. Learner's growth in Mathematics involves more than just mastering computational skills. Thus, identification of mathematical talent using only speed and accuracy of computation would qualify hand-held calculators to be called talented mathematicians.

Across the globe, proficiency in Mathematics now ranks at the top of educational priorities along with proficiency in reading and writing. It implies that mathematical reasoning and problem-solving should be an integral component of school curriculum and instruction in the sciences, the same way that reading and writing are. Undertaking Mathematics lesson at the level of commercial thinking (General Mathematics) for the purpose of creating minimal value for citizens to do simple record keeping task may not be sufficient for our quest provide necessary mathematical background for further education as today's businesses run with spread sheets, sophisticated forecasting models and statistical quality control. Hence, developing quantitative intelligence (advanced, pure or applied Mathematics) would seem to be a national strength.

At the beginning of this chapter, it was mentioned that Mathematics curriculum is expected to make contact with at least three areas of reality. The present-day reality is that teaching methods and learning environment are predictive variables for students mastering, understanding and performance. With the advent of Information and Communication Technology (ICT), attention must be drawn to availability of the computer and other ICT facilities, and its role in changing the face of Mathematics. The computer is changing Mathematics by bringing certain topics into greater prominence - it is even causing mathematicians to create new areas of Mathematics (the theory of computational complexity, the theory of automata, mathematical cryptology). It makes it possible to rapidly and painlessly carry out numerical work, so that we may accompany our analysis of a given problem with the actual calculation of numerical examples. The direction to go is to sustain learners' interest vis-à-vis display of practical usefulness and application of Mathematics to daily life by reducing or eliminating the approach of theorisation of Mathematics concepts. It means our classroom facilities in term of creating well-equipped and functional Mathematics laboratories in schools with trained teachers to handle resources for hands-on experience among learners is desirable.

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