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MATHEMATICS AND CURRICULUM DEVELOPMENT

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Abstract
The unprecedented changes that are taking place in today's world will profoundly affect the future of today's students. To meet the demands of the world in which students will live, students will need knowledge of mathematics to adapt to changing conditions and to learn independently. Mathematics is the abstract study of topics such as quantity (numbers), structure, space and change. Major development in mathematics education in this millennium has been the increased amount of mathematics that all citizens are expected to know. Today's mathematics curriculum must prepare students for their future roles in society by equiping them with essential mathematical knowledge and skills of reasoning, problem solving, communication and most importantly, with the ability and the incentive to continue learning on their own. This paper focuses on the mathematics and curriculum development which includes what is mathematics, mathematics processes, curriculum and curriculum development, processes of planning and development of curriculum. Problems and prospects of mathematics teaching in Nigeria secondary schools were also discussed, while recommendations were provided.
Keywords: *Curriculum development, Mathematics education, Problem-solving skill*

1. What is Mathematics

Mathematics is the abstract study of topics such as quantity (numbers), structure, space and change. There is a range of views among mathematicians and philosophers as to the exact scope and definition of mathematics. Mathematicians seek out patterns and use them to formulate new conjectures. Mathematicians resolve the truth or falsity of conjectures by mathematical proof. When mathematical structures are good models of real phenomena, then mathematical reasoning can provide insight or predictions about nature. Through the use of abstraction and logic, mathematics was developed from counting, calculation, measurement, and the systematic study of the shapes and motions of physical objects. Practical mathematics has been a human activity for as far back as written records exist. The research required to solve mathematical problems can take years or even centuries of sustained inquiry (Gowers, 2008, Edward, 2013, Ziegler & Loos, 2016). Example is that of 40 years mathematical problem solved by a university don at Federal University, Oye Ekiti, Nigeria.

Mathematics as a tool for national development, Ilori (1994) stated that societies and government around the world recognises the importance of mathematics for 'national development'. The fabric of society has become more and more underpinned by mathematical ideas. As a result, a major development in mathematics education in this millennium has been the increased amount of mathematics that all citizens are expected to know. Technological leaders and political leaders need mathematics education that takes into account both the new uses of mathematics and technology and new ways in which mathematics can be done with information technology. Wherever a person belongs in a society, he utilizes knowledge of mathematics in one form or the other. Not to speak of an engineer, a businessman, an industrialist, a banker and a financer or a finance minister; a planner or a boss in a parastatal, even a labourer has to calculate their wages, make purchases from the market and adjust the expenditure to their income. Whosoever earns and spends uses mathematics. Counting, notation, addition, subtraction, multiplication, division, weighing, measuring, selling, buying and many more are simple and

fundamental processes of mathematics which require immense practice. The knowledge and skills in these processes can be provided in an effective and systematic manner only by teaching mathematics in schools (Kulbir, 2006).

2. The Mathematics Processes

The mathematical processes that support effective learning of mathematics are as follows: Problem solving, reasoning and proving, reflecting, selecting tools and computational strategies, connecting, representing and communicating. The mathematical processes are interconnected. Problem solving and communicating have strong links to all the other processes. A problem-solving approach encourages students to reason their way to a solution or a new understanding. As students engage in reasoning, teachers further encourage them to make conjectures and justify solutions, orally and in writing. The communication and reflection that occur during and after the process of problem solving help students not only to articulate and refine their thinking but also to see the problem they are solving from different perspectives. This opens the door to recognizing the range of strategies that can be used to arrive at a solution. By seeing how others solve a problem, students can begin to think about their own thinking (metacognition) and the thinking of others, and to consciously adjust their own strategies in order to make their solutions as efficient and accurate as possible. The mathematical processes cannot be separated from the knowledge and skills that students acquire throughout the course. Students must solve problem, communicate, reason, reflect, and so on, as they develop the knowledge, the understanding of concepts, and the skills required in the course.

3. Curriculum and Curriculum Development

In contemporary educational usage, the curriculum at the school consists of all the experiences that a learner encounters under the direction of the school. Furthermore, the modern concept of curriculum includes the programme of studies, the method of instruction employed in each course, the guidance programme of the school and the extra class-activities programme. The content of the curriculum and the methods employed to present the content have to be determined by the society, the learner, and the subject (Badmus, 2002). Hosford in Badmus (2002) defined curriculum as the set of experiences planned to influence learners towards the goals of an organization. Organization here refers to both schools and many other different situations for which courses may be run.

Curriculum development implies the planning of these learning experiences, the aims of which are to bring about some derived change in the students and the assessment of the extent to which these changes have taken place. One can perhaps bring to bear here, the argument that curriculum development is but one form of reform intended to bring a change in the educational system. A responsive curriculum is particularly central to the achievement of the uttermost goal of education, that is, the total development of the child. According to Hosford in Badmus (2002) the curriculum planning and development include agreement on the essential elements of the task:

(i) Statement of objectives and purpose
(ii) Content selection
(iii) Organization and determination of the sequence of learning opportunities
(iv) Selection of materials and facilities
(v) Evaluations (purpose, content, sequences, materials and evaluation)

Curriculum development design is a part of a whole process of curriculum renewal according to Badmus (2002).

4. The Processes of Planning and Development of Curriculum

According to Azuka (2015) five stages of operation are involved in the process of curriculum planning and development. These are goal determination, technical operations (Technology), the application stage (Try out), implementation and evaluation.

Goal Determination (Aims and Objectives)

This function involves the determination of the general educational aims and specification of major objectives. The general aims of education are of political significance. They are usually stated in broad terms so that they secure the consensus of the great majority of the society. They serve as the basis for making decisions on how school life should be organized and what should be taught in school, but in themselves they do not constitute or directly determine the practical details of school life. (Longe, 1984, Azuka, 2015). Examples of such political aims are that education should be a preparation for life, ''increase the supply of high level manpower'' or develop a ''more complex thinking in children. General education aims are formally stated by Governmental or Legislative acts. Decisions about curriculum objectives are affected by three basic factors. They are the learner, the society and the subject matter (discipline) (Badmus, 2002).

The society – The needs, values and other social forces influence and demand upon the institutions of learning. The society is in a constant state of change. As a result of this, the curriculum planner should select educational objectives that take these changes into consideration. It is the role of the curriculum planner to analyze the implications of changes in the society when deciding upon the new programme of study for the school (Azuka, 2015). Some of the changes in the society to be considered include employment pattern since schools are to provide basic skills, and the requirements arising from the development of new behaviour in health, welfare and political activities. A case in point is the inclusion of ICT, HIV/AIDS education and quantitative reasoning in the Basic Education curriculum for mathematics in 2006. (FME, 2006 and Azuka, 2015)

The needs of the learner. This includes the characteristics of the learner and how h/she learns. As in the case of the society, the employment and occupational needs of the learner are to be considered in curriculum planning. This is because the essence of education is to make one fit to live and fit to live with (Azuka, 2015).

Subject matter. Here we consider the specialized fields of knowledge, the nature and philosophy. Just as the society is in a constant state of change so also is the subject matter in a constant state of change. In this regard the curriculum to be devised has to consider the introduction of new findings, topics structures…, that are relevant to living in the contemporary setting (Azuka, 2015). Usually when the educational programme organized according to subject matter, with unique curriculum materials developed for each subject, the major educational objectives (MEO) inherent in them or which can be obtained through their study have to be identified. The MEO delineate broad areas of human behaviours and should first be translated into more specific guidelines for preparing instructional materials (Akangbou, 1984).

Application (Try out)

The application stage refers to ''try out and revision whereby educational programmes would be empirically tried out before they are approved for use on a large scale basis" In general, little regard is given to this idea of combining or complementing professional wisdom

with empirical evidence for the job of materials preparation (Longe, 1984). Many curricula have failed in the past because of lack of try out of the curricula before implementation. Many of them are approved based on the subjective judgment by the educationalauthorities.

At this stages, the curriculum team should carefully observe the teaching – learning process in the classroom situation, employ a variety of formative evaluation, instruments including tests and students work sheets. The team should encourage both teachers and students to point out problems and difficulties encountered in the programme. Also, the programme, should be submitted to various types of experts to pass judgement upon the material, indicate any specific modification that is necessary. On the basis of results of both the empirical trial run and the experts' judgments, a series of recommendations would be made concerning desired alterations of the original version of the programme.

Implementation

Implementation refers to an open use of the curricula throughout the entire school system. This would entail a number of changes within the educational system. Some of the activities are the provision of teaching – learning and inservice training for principals, teachers and school supervisors. (Longe, 1984; Akangbou, 1984). The success of any curricula depends on the provision of the required instructional materials and the readiness of the school principals, teachers and inspectors. Many curricula in Nigeria have failed due to lack of compliance to this implementation strategy. Besides, the implementation of the curricula have to be monitored to ensure the achievement of the objectives of the curriculum. Any discovery would have to becorrected.

Evaluation

The process of evaluation according to Tyler, is essentially the process of determining to what extent the educational objectives are actually being realized by the programme of curriculum and instruction. In other words, the statement of objectives not only serve as the basis for the selection and organization of learning experiences but the standard against which the programme is assessed. To Tyler then evaluation is a process by which one matches initial expectation in the form of behavioural objectives with outcomes. Such a conception of curriculum planning has a certain commonsensical appeal and especially when fortified with models from industry and systems management, it seems a supremely wise and practical way to appraise the success of a venture according to Tyler in Badmus(2002).

5. Models For Curriculum Development

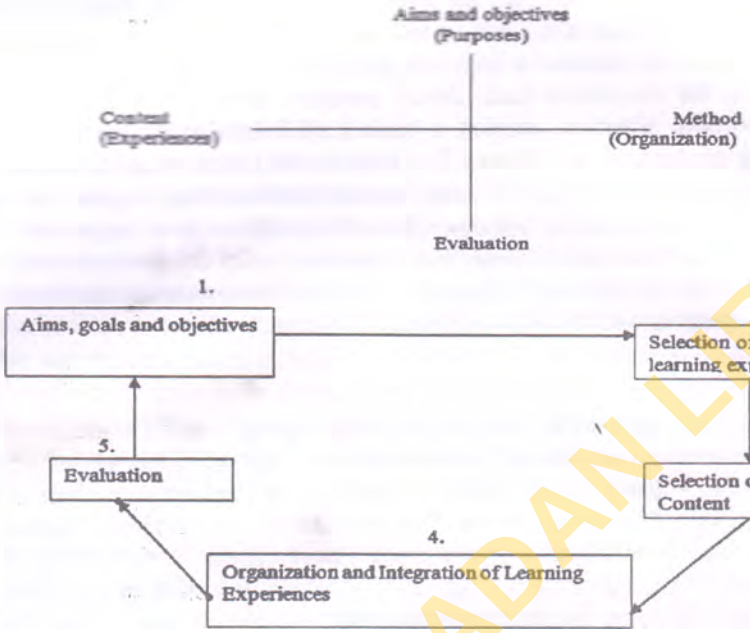
Some of the Models for curriculum development are shown below:

Tyler's Model

Tyler in Badmus (2002) based his work on four fundamental questions:

(1) What educational purposes should the school seek to attain?
(2) What educational experiences can be provided that are likely to attain these purpose?
(3) How can these educational experiences be effectively organized? and
(4) How can we determine whether these purposes are being achieved?

No attempt was made by Tyler to answer the questions; he argues that the answers will vary from one level of edueation to the other and suggests methods of studying these methods and his model is presented thus:



Tyler's Model

Wheeler's Model

Some people have argued that the Tyler model is rather too simple and suggest that evaluation need not be a terminal process, but should take place at every stage. Wheeler converted Tyler's original ideas into a cyclic form with five phases according to Wheeler in Badmus (2002)

Wheeler's Model

6. Problems and prospects of mathematics teaching in Nigeria secondary schools

Despite the effort of the government on the development of mathematics teaching and provision of opportunities for the improvement of teaching, there are still problems of mathematics teaching and learning. Odili (2006) outlined some of these problems as follows:

1) Lack of curriculum integration.
2) Shortage of mathematics teachers.
3) Lack of instructional materials.
4) Poor government policy.
5) Poor classroom organisation by teachers.
6) Lack of equipped mathematics laboratory for practical.
7) Over population of students which may impedes effective demonstration during practical.
8) Teachers impatience and un-preparedness.
9) Poor remuneration of teachers.

Prospects of mathematics teaching

Looking at the numerous achievements recorded in mathematics education in Nigeria in the 21st century, there are more challenges ahead of mathematics teaching. There have been efforts in mathematics curriculum development to correct these problems, but there appears to be more challenges in mathematics teaching and learning as summarised:

i) With the establishment of more institutions and efforts of ministries of education, there is possibility of improving mathematics teacher's supply in the near future.

ii) With the knowledge of mathematics, sciences and technology and in particular the mathematics application to the development of the society is the centre piece of essence of engineers, Technicians and scientists clubs and national competitions. To stimulate creativity, improvisation, interest in mathematics and technology and productive work in and out of school.

7. The Place of Mathematics in the Curriculum Development

The unprecedented changes that are taking place in today's world will profoundly affect the future of today's students. To meet the demands of the world in which they will live, students will need to adapt to changing conditions and to learn independently. They will require the ability to use technology effectively and the skills for processing large amounts of quantitative information. Today's mathematics curriculum must prepare students for their future roles in society. It must equip them with essential mathematical knowledge and skills; with skills of reasoning, problem solving, and communication; and, most importantly, with the ability and the incentive to continue learning on their own. This curriculum provides a framework for accomplishing these goals.

The choice of specific concepts and skills to be taught must take into consideration new applications and new ways of doing mathematics. The development of sophisticated yet easy-to-use calculators and computers is changing the role of procedure and technique in mathematics. Operations that were an essential part of a procedures-focused curriculum for decades can now be accomplished quickly and effectively using technology, so that students can now solve problems that were previously too time-consuming to attempt, and can focus on underlying concepts. In an effective mathematics program, students learn in the presence of technology. Technology should influence the mathematics content taught and how it is taught. Powerful assistive and enabling computer and handheld technologies should be used seamlessly in teaching, learning, and assessment (CBT). This curriculum integrates appropriate technologies into the learning and doing of mathematics, while recognizing the continuing importance of students' mastering essential numeric and algebraic skills.

Mathematical knowledge becomes meaningful and powerful in application. This curriculum will embed the learning of mathematics in the solving of problems based on real-life situations. Other disciplines are a ready source of effective contexts for the study of mathematics. Rich problem-solving situations can be drawn from closely related disciplines, such as computer science, business, recreation, tourism, biology, physics, or technology, as well as from subjects historically thought of as distant from mathematics, such as geography or art. It is important that these links between disciplines be carefully explored, analysed, and discussed to emphasize for students the pervasiveness of mathematical knowledge and mathematical thinking in all subject areas.

The development of mathematical knowledge is a gradual process. A coherent and continuous program is necessary to help students see the "big pictures", or underlying principles, of mathematics. The fundamentals of important skills, concepts, processes, and attitudes are initiated in the primary grades and fostered through elementary school. The transition from elementary school mathematics to secondary school mathematics are very important in the student's development of confidence and competence.

The senior secondary school courses in the curriculum build on the knowledge of concepts and skills that students are expected to have by the end of Junior class. The strands used

are similar to those of the elementary program, with adjustments made to reflect the new directions mathematics takes in secondary school. The senior secondary school courses are based on principles that are consistent with those that underpin the elementary program, facilitating the transition from elementary school. These courses reflect the belief that students learn mathematics effectively when they are initially given opportunities to investigate ideas and concepts and are then guided carefully into an understanding of the abstract mathematics involved. Skill acquisition is an important part of the program; skills are embedded in the contexts offered by various topics in the mathematics program and should be introduced as they are needed.

The senior secondary school mathematics curriculum should design be to foster the development of the knowledge and skills students need to succeed in their subsequent mathematics courses, which will prepare them for the postsecondary destinations of their choosing.

7. Roles and Responsibilities of Stakeholders in Mathematics Curriculum Development

Students: Students have many responsibilities with regard to their learning in school. Students who make the effort required and who apply themselves will soon discover that there is a direct relationship between this effort and their achievement, and will therefore be more motivated to work. There will be some students, however, who will find it more difficult to take responsibility for their learning because of special challenges they face. For these students, the attention, patience, and encouragement of teachers and family can be extremely important factors for success. However, taking responsibility for one's progress and learning is an important part of education for all students, regardless of their circumstances.

Successful mastery of concepts and skills in mathematics requires a sincere commitment to work and study. Students are expected to develop strategies and processes that facilitate learning and understanding in mathematics. Students should also be encouraged to actively pursue opportunities to apply their problem-solving skills outside the classroom and to extend and enrich their understanding of mathematics.

Parents: Parents have an important role to play in supporting student learning. Studies show that students perform better in school if their parents or guardians are involved in their education. By becoming familiar with the curriculum, parents can find out what is being taught in the courses their children are taking and what their children are expected to learn. This awareness will enhance parents' ability to discuss their children's work with them, to communicate with teachers, and to ask relevant questions about their children's progress. Knowledge of the expectations in the various courses also helps parents to interpret teachers' comments on student progress and to work with them to improve student learning.

The mathematics curriculum promotes lifelong learning not only for students but also for their parents and all those with an interest in education. In addition to supporting regular school activities, parents can encourage their wards to apply their problem- solving skills to other disciplines or to real-world situations. Attending parent-teacher interviews, participating in parent workshops, becoming involved in school council activities (including becoming a school council member), and encouraging students to complete their assignments at home are just a few examples of effective ways to support student learning.

Teachers: Teachers and students have complementary responsibilities. Teachers are responsible for developing appropriate instructional strategies to help students achieve the curriculum

expectations for their courses, as well as for developing appropriate methods for assessing and evaluating student learning. Teachers also support students in developing the reading, writing, and oral communication skills needed for success in their mathematics courses. Teachers bring enthusiasm and varied teaching and assessment approaches to the classroom, addressing different student needs and ensuring sound learning opportunities for every student.

Recognizing that students need a solid conceptual foundation in mathematics in order to further develop and apply their knowledge effectively, teachers endeavour to create a classroom environment that engages students' interest and helps them arrive at the understanding of mathematics that is critical to further learning. Using a variety of instructional, assessment, and evaluation strategies, teachers provide numerous opportunities for students to develop skills of inquiry, problem solving, and communication as they investigate and learn fundamental concepts. The activities offered should enable students not only to make connections among these concepts throughout the course but also to relate and apply them to relevant societal, environmental, and economic contexts. Opportunities to relate knowledge and skills to these wider contexts – to the goals and concerns of the world in which they live – will motivate students to learn and to become lifelong learners.

Principals: The principal works in partnership with teachers and parents to ensure that each student has access to the best possible educational experience. To support student learning, principals should ensure that the curriculum is being properly implemented in all classrooms using a variety of instructional approaches. They should also ensure that appropriate resources are made available for teachers and students. To enhance teaching and learning in all subjects, including mathematics, principals should promote learning teams and work with teachers to facilitate participation in professional development.

9. Conclusion

The essence of the educational curriculum of any nation is geared towards producing ideal men and women in the society. Any error in the planning and development of the curriculum affects the entire educational system. Hence, curriculum planners must ensure the stages of curriculum are followed. These include goal determination, selection of objectives, organization, try out, Implementation and Evaluation. Curriculum development is dynamic and changes as the societychanges.

10. Recommendations

The following recommendations were made:

i. Curriculum developers should recognise that providing problem solving experiences is critical if students are to be able to use and apply mathematical knowledge in meaningful ways. It is through problem solving that students develop deeper understanding of mathematical ideas, become more engaged and enthused in lessons, and appreciate the relevance and usefulness of mathematics.

ii. Government should make available valuable resources examples of useful non-routine problems, particularly in textbooks.

iv. Mathematics curriculum should equip learners with essential mathematical knowledge and skills; with skills of reasoning, problem solving, and communication; and, most importantly, with the ability and the incentive to continue learning on their own.

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