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REVOLUTIONIZING MATHEMATICS EDUCATION: INNOVATIVE METHODS FOR CURRICULUM DESIGN AND ASSESSMENT IN NIGERIA

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Abstract: In any society, education plays a pivotal role in meeting the needs and demands of its populace. The responsiveness of education to these societal needs forms the basis for curriculum development, which aims to equip individuals with the requisite skills, attitudes, values, and competences necessary for societal advancement. However, defining curriculum proves to be a multifaceted endeavor, as experts offer diverse interpretations of this fundamental concept. Historically, curriculum was predominantly viewed as the mere content of instruction, devoid of considerations for instructional methodologies. Yet, in the contemporary educational landscape, this antiquated notion no longer suffices.

This abstract delves into the evolution of curriculum discourse, highlighting the shift from a narrow focus on instructional content to a comprehensive approach that encompasses diverse aspects of education. In particular, it critiques curriculum designs that prioritize content over pedagogical strategies, likening them to examination syllabuses, such as those employed by examination bodies like WEAC. Through critical analysis, the abstract emphasizes the imperative for modern curricula to transcend mere content dissemination and instead prioritize holistic educational outcomes. It underscores the importance of aligning curriculum development with societal needs and adopting innovative instructional approaches to foster meaningful learning experiences. Furthermore, it underscores the necessity for ongoing dialogue and reflection within the educational community to ensure that curricular practices remain responsive, relevant, and transformative in addressing the evolving needs of society.

Keywords: Curriculum development, societal needs, instructional methodologies, examination syllabuses, educational outcomes

INTRODUCTION

It is an assertion that in every society education ought to be responsive to the needs of the society it is intended to serve. Once these needs are identified the curriculum is then fashioned to train and impact the required skills, attitudes, values and competences for realization of such societal needs. Curriculum is variously defined by different experts. This is why there is no single acceptable definition of this concept. At the turn of the last century, curriculum was regarded as the content of instruction without reference to the ways and means modern of

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instruction. This definition no longer holds for modern education. Any curriculum that puts an emphasis on contents of instruction only is an examination syllabus. WEAC syllabuses are typically for examinations. We shall return to this point.

A comprehensive and an all-inclusive definition have been given in Kanu by Ali (2018). To him, curriculum is the sequenced contents or course of instruction needed by the learner who is expected to demonstrate some objectives or behavioral change, following instruction and experience in some contents, provided by schools (teachers and administrators) and based on a structured form of continuing evaluation. From this definition it is clear that new sub-concepts crop up. These sub-concepts include contents, learner's needs, interests and abilities, objectives or behavioral changes, instruction and experiences, provided by schools and evaluation as a continuing initiative throughout the sequenced instruction. These sub-concepts have all been carefully explained elsewhere by Olaitan and Ali (2008). It is hardly necessary now for one to explain the sub-concepts except to say that the explanations given by the two authors are rather progressive and analytical. For instance, they see curriculum content in terms of how it relates to the national and individuals objectives in a course rather than its effects; learning of content may not result in achieving an objective if both content and objectives are not closely related. One can learn a content without achieving the objectives of the learning of the content accomplished. From the foregoing, it can be concluded that any definition of the curriculum should be so carefully thought-through so as to bring out the links between content, goals/objectives, the needs, interest and abilities of the learner, methods of instructions to be used, the experiences to be provided the learners, the teacher and administrator factors in a formal and ideal school environment as well as the provision of a continuity in contents and methods of evaluation.

MEANING OF CURRICULUM

It should be noted that there is no universally accepted or precise definition of the term curriculum. Tanner and Tanner (1975) observed that the issue of not having a definition that is universally agreed upon is not only peculiar to curriculum alone. Such a problem, they explained, also faces other fields of scholarship like the sciences and social sciences, etc., the varying or changing conception of the term, they explain, has its root in the changing nature of knowledge, changing conception of the learner and of the learning process, and also on the 'widening expectation of the functions of the schools within the society.

Curriculum according to Kiley (2013) in Dirgu is all the planned learning opportunities offered to learners by the educational institution and the experiences learners encounter when the curriculum is implemented. Higher Education Academy in Mukoro (2022) viewed curriculum as: What it is to be learnt – content; why it is to be learnt – process; how it is to be learnt – process; when it is to be learnt – structure of the learning process. It includes consideration of how the learning will be demonstrated and achievement assured. Furthermore, Stobie (2007) presented the concept of curriculum as a diversity of elements which can be separately identified as contributing to the learning process. From the definitions, it can be said therefore, that curriculum is the sum total of all the experiences which the learner receives under the tutelage of the school with cognizance to the subject matter, the learner and the society. In spite of the problem of defining curriculum, it must be noted that curriculum experts and educators have reached some understanding as to what constitutes the term curriculum. The four elements of curriculum include: (i) goals and objectives; (ii) content or subject and subject matter; (iii) learning experiences; and (iv) evaluation. Of note will be the brief analysis of curriculum by highlighting the meaning of the terms syllabus, scheme of work, unit of work, lesson plan/note. This approach will make the distinction

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between curriculum and those terms clearer and further brings to the fore, the applicability of these four elements of curriculum.

Syllabus

Syllabus can be referred to as a condensed outline or statement of the main points of a subject or course for a period the learner is in school (Ughamadu, 2018). The syllabus is usually topic-oriented, and is derived from the broad curriculum of the school. It can also be regarded as a subset of the curriculum. Thus, the content element of the curriculum is synonymous with the syllabus, and is usually the topics to be covered' by a group of learners for a given period of time.

The syllabus is usually drawn up by examination bodies, for example, the West African Examination Council (WAEC) and the National Examination Council (NECO) or the government through its Ministry of Education, agencies, and in some situations in conjunction with universities and examination bodies.

Scheme of work

This is in turn derived from the syllabus. It is the breakdown of the syllabus into manageable portions on yearly or termly basis. Thus, when an individual teacher splits the entire syllabus into manageable portions, a syllabus is regarded as having been reduced to a scheme of work. The breakdown of the syllabus into scheme of work is usually approached in a systematic way, and is done to facilitate the coverage of the syllabus.

Unit of work

When the termly scheme of work is broken down further into smaller portions that could be dealt with within a period of a few weeks, we have a unit of work being put in place.

Lesson plan/note

This can be referred to as an outline of what the teacher and the student will do in the course of a lesson period, so that the students can achieve or attain pre-specified instructional objectives. The lesson note, on the other hand, is a detailed account of the activities the teacher and the students would be engaged in during the course of the lesson. The lesson note is more detailed than the lesson plan. In short, the lesson plan indicates what is to be done, while the lesson note, in addition to indicating what is to be done, also indicates details of how it is to be done.

Planning the mathematics education curriculum

The curriculum is a guide that gives purpose and direction to the specific activities of the class, the teacher must complete for students to achieve measurable goals. These guidelines must be planned in recognition of three major components. The components are:

Purposes of the curriculum

The fundamental job of the curriculum planner is to identify the purpose or objectives of the mathematics curriculum as a whole and in its component parts. The objectives are usually drawn from what is to be done and these are stated in practical, realistic, and achievable concepts.

Current knowledge level of students and continuity

To plan a mathematics education curriculum for any school level, it is essential that the curriculum planners have a thorough familiarity with the nature and scope of the work the students had previously completed, their current abilities and a projection of students' capacity to actively participate in and benefit from the proposed curriculum. They must also determine the expected aspects of the content of the curriculum; activities, content, exercise, suggestions for further readings, field trips and so on, will take into cognizance what students already know and

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what much of gains they can make from using the proposed mathematics and the length of time necessary for completing it. The activities and experiences to be included in any curriculum are sequenced in such a way that a reasonable uniformity for each level or stage is built into the planned curriculum. Also, the curriculum may contain instructions to the teacher on what kinds of pedagogical adaptations are necessary for him to drive him his points to students of different ability levels. The assumption here is that the teaching methodology employed in teaching a concept is a crucial factor with regard to whether learning occurs or not.

METHODOLOGY

The third item that curricula planners usually conceived is the idea of ensuring that the selected materials (content of the curriculum) to be studied are suited to the needs, interest, abilities and expectations of students, the nation and industry. This calls for the trial of the mathematics curriculum under a setting (age, class, language and so on) similar to the actual school situation in which the curriculum will be used in teaching-learning processes. The need for trying-out the curriculum is obvious; for determining its appropriateness for the student who will use it and for the government and industry that will use it for expertise gained from training the students.

Developing the mathematics education curriculum

The practical aspect of developing a planned curriculum involves more professional activities. These activities follow a number of clearly defined steps one step subsumes the next proceeding step and consists of actions that ideally must be successfully completed before going to the next step. The first step in curriculum development involves the collecting, analysing and interpreting of research data related to the type of students who will use the curriculum being planned (mental and chronological age, computational and motor skills), grade the proposed curriculum is expected to enable the learner achieve in terms of his aspirations and those of the nation, the identification of the facilities needed for and available for implementing the proposed curriculum; as the examining of materials produced already. All of these information are useful in revising the curriculum or developing a new one. These information are made available to the team of educational experts who assemble to take a closer look at the various aspects of the information listed earlier with the intention of using such information for developing a new curriculum.

The next step in curricula development is the generous provision of funds for calling experts together for the development of the curriculum, in terms of objectives, the content of instruction vis-a-vis the appropriate class levels and appropriate units or themes, the instructional activities to be carried out as well as evaluation procedures and remarks. This task is an arduous one suggesting that there is no short cut to curriculum development. Sometimes the accomplishment of this task takes one month or more. Specifically, the task at hand may involve the breaking down of the curriculum development team into working committees, the number of which may be decided by the curriculum development committee chairman or by all the members of the curriculum development team. There may be a committee charged with writing objectives for the curriculum, another group may be charged with the arrangement of the order of activities and topics based on the classes that will use it.

Developing the curriculum may equally involves the efforts of a smaller committee (consisting of general curriculum experts and a few impartial experts in the particular subject area but who do not belong to any particular interest group) in critiquing the tentative curriculum draft as a whole. This committee's effort is to see that the curriculum is consistent, maintains sequence and continuity, fits into the overall school programme and satisfies the needs and capabilities of the students and the nation. It is at this state of the curriculum development that efforts are made to ensure that it is likely to provide the students, through using it, a growth in the understanding and applications of the concepts, acquisition of the right attitudes toward the structure and functions

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of the particular subject for which the curriculum was developed, thus enabling students find meaning in and purpose from studying mathematics. A field trial of the newly developed curriculum is often carried out to determine its efficacy, usefulness and relevance as a means of enabling the learner acquire the objectives of instruction, after or when he is taught. This field trial is a sine-qua-non in curriculum development.

IMPLEMENTING THE MATHEMATICS EDUCATION CURRICULUM AND DISSEMINATION

After the curriculum is developed it may be adopted for use in the school system. Implementing the curriculum is as difficult, if not more difficult than developing it. The reasons for making this statement are quite obvious. For example, the facilities required for implementing the curriculum effectively surpass those required for developing it. The problems often encountered in implementing the curriculum can be broadly put into three main groups. The first groups of problems are schools. Qualified and sufficient numbers of dedicated mathematics teachers are needed to teach the contents or the directives of the curriculum; whether they are available and to what degree they effectively perform their teaching role, affect the degree to which the objectives of the curriculums are achieved. Secondly, there is the problem of availability of instructional materials and equipment for an effective implementation of the curriculum materials (textbook charts, projections, model and so on) and equipment problems. In terms of availability in sufficient useable numbers and conditions, must be fully addressed. These items are the tools the Iyemekpolor and Mathematics teacher needs to be able to successfully teach the concepts contained in the curriculum. Clearly, the most crucial problem is curriculum implementation is money. This is because money is essential for the procurement of needed materials and services, as the need arises, for implementing the curriculum.

EVALUATION IN MATHEMATICS CLASS

At the end of every mathematics lesson or after a period, the teacher would want to know if the students have mastered the materials presented to them. In this case, he may use assignment, classroom exercise, test or examination. Some of these are immediately (diognastic evaluation) used to determine the progress of learning while others may be summative to summarize the unit or level of activities. The mathematics teacher may carry out evaluation in mathematics class focusing on the following: ability testing and modes of testing in mathematics (Ezenweani, 2006).

Ability testing in mathematics

Knowledge

This tests the students ability to recall facts connected with the topic or activity. This includes assessment such as definition, explanation, labeling, etc.

Understanding

This includes ability to apply the facts learnt. Use power of deduction. Ability to recognize problems and choose appropriate means to solve them. For example, the child may be required to find two consecutive numbers whose sum is 8 and their product is 15. Here, he should prove his understating of the terms consecutive, sum and product, express algebraic equations and apply the principle of simultaneous equation.

Skills

These include the acquisition of skills applicable to particular activity or subject like the ability to apply algorithms in arithmetic problems, the skill to construct diagram in geometry; carry out operations in algebra or demonstrate relationship on the study of trigonometry. These include the ability to correctly calculate, use tools and techniques for drawing, etc.

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Originality

This includes the ability to demonstrate creativity, original thought and taking initiative. In this case, a child should be allowed to solve given problem from his point of view or design a project in mathematics on his own.

Neatness

Here, the child is assessed to find out how much he has learnt the presentation of solution format, arrangement of his work in neat order. He should demonstrate his appreciation of patterns often found in mathematics lesson, construct neat diagrams and appreciate the elegance of mathematics. He should demonstrate his appreciation of patterns often found in mathematics lesson, construct neat diagrams and appreciate the elegance of maths. Consider the two setting A and B:

$$(A) - (+3)(+2) = +6$$

$$(+3)(+1) = +3$$

$$(+3)(+0) = 0$$

$$(+3)(-1) = -3 \quad (+3)(-2) = ?$$

$$(+3)(-3) = ?$$

$$(B) - (-2)(+3) = -6, (-2) = -4, (-2)(+1) = -1, (-2)(0) = ? \quad (-2)(1) = ?$$

Oral

The child should demonstrate ability to participate in class discussion using mathematical language and terms. Very often, students in secondary school find it difficult to read mathematics book on their own. Mathematics is not to be solved only but should also be read with understanding. For example, how can you read the following?

$$a^m \cdot a^n = a^{mm}$$

$$(a) \quad \cos A = b/c$$

$$(b) \quad 3.45 \times 0.5$$

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Cooperation

This includes the ability to accept others, to pool knowledge together and work cooperatively in a group. It includes attitude to authority and readiness to obey or take command when needed.

Persistence

The study of mathematics requires persistence since some problems are so difficult that just one attempt or few minutes working cannot bring out solution. In such cases, the learner is expected to persist till solution is found.

Modes of testing in mathematics

Test and examination are basically the same in terms of functions. Only that test is used commonly to refer to the in-the-class and teacher based instruments for evaluation, while examination refers to the end of course, end of term or end of year tests. In either of the two, we shall consider the following as ways of assessing the learning outcomes in the class.

Open book test

This method emphasizes the understanding of the principles learned and their application. The teacher directs the students to particular assignment in textbooks to be solved with the aid of the book itself. It will be expected that the learner should be able to follow the set out method in the book to solve the problem. It serves the same purpose of assessing how well a child can read on his own (independent study). This type can also reduce the problem of

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cheating since the child may be allowed to cooperate but still maintain orderliness and peaceful atmosphere in the test room (Ezenweani, 2006).

Reading test

This allows the student to comprehend the knowledge and convert in some cases the ideas into mathematics terms or expressions. The teacher would use this to emphasize the need to read with accuracy to the mathematical texts. As the ability to read mathematics expressions increases among the students, their performance in the subject will also improve.

Performance test

This method emphasizes standard of operation in practical skills. Example of this is drawing a diagram to scale rate of operation and the reality of bringing out the desired information, in the task presented. This also includes manipulative skills, problem solving abilities, deductive techniques, demonstration of ingenuity, etc. As soon as the standard is set out, the teacher could then assess the degree of performance by the student.

Achievement tests

This includes the essay and objective tests. The essay test emphasizes communication skills and the ability to achieve certain standards in integrating certain ideas clearly. The essay tests items are easy to set but the assessment is subjective. This is because the rating is affected by the state of mind of the assessor. On the other hand, two different assessors can assess the same material differently. And the consequence upon this is the fact that in mathematics, students can apply different approaches in solving the same problem and the techniques also vary. When methodology becomes the rudiment for assessment, students make a lot of mistakes that can affect the judgment of their work (Ezenweani, 2006).

Evaluation problems and solutions in mathematics education

Although Nigeria has successfully developed and introduced several curriculum in her schools, several questions about their relevance, effects, usefulness and efficacy remain unanswered, as in school use aspect of the majority of the curricula materials are concerned. At the classroom level most teachers scurry or are made to scurry to cover each term's work on schedule. They seldom internalise the document, their professional bodies, governments and so on; there are teachers who believe that they do and are seen to do a very good job of teaching if and only when they cover the contents of the curriculum for their class. They completely ignore the issue of effectiveness of the curriculum being used in terms of whether it really enables a large number of their students attain the objectives of instruction. They are oblivious of the effects which the use of the curriculum has on student's interests, ability, attitudes, etc., towards the particular subject of the curriculum. Thirdly, they remain mute in the face of lack of funds, the prevailing incidence of exorbitant textbooks that are sometimes out of stock or outdated, and the general unprofessional ethics of rushing through work that should ordinarily take longer time to be more thoroughly finished. This author has never ceased to be amazed by the enormity of work school certificate students are expected to cover in their three-year senior secondary school term (Ali, 2008).

To achieve the ultimate goal of ensuring that any curriculum in mathematics is relevant, useful and teachable, the point at which to begin the search for this aim is through the empirical document of facts obtained as the curriculum is used in schools; a curriculum evaluation issue. More curriculum evaluation studies of the various curricula in use in mathematics which are nationwide, international and or long-term in scope are needed and the reports of their findings communicated to curriculum development and mathematical centers in Nigeria.

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Therefore, evaluation of mathematics curriculum should concentrate on aspects levels of attainment of objectives (intended, unintended and unattained), efficacy of programmes, and resource allocation.

CONCLUSIONS AND RECOMMENDATIONS

The paper looked at the issues of what curriculum, curriculum development and evaluation in mathematics education are, as well as implementation and evaluation with enhances on mathematics education. Evaluation in mathematics class, evaluation problems and solutions in mathematics education were also discussed. Therefore, the following recommendations are made:

- (1) The opinions of teachers, school authorities and students should be sought in curriculum development in Nigeria.
- (2) Field validation and face validation of curriculum materials in mathematics education.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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