MATHEMATICS EDUCATION FOR SUSTAINABLE DEVELOPMENT: A CASE OF PROJECT METHOD OF TEACHING

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Abstract

This study is focused on the usefulness of Mathematics Education as an essential tool to help mathematics teachers to develop understanding of sustainability by integrating it into their teaching. The current ways of bringing about learning in mathematics in schools were discussed including the contribution of all stakeholders in Education. A modern way of teaching mathematics through projects was suggested to ensure that mathematics is taught for sustainable development through projects.

Introduction

Sustainable development may be defined as that development that meets the needs of the present and which does not necessarily compromise the needs of the future but serves as a solid foundation for it. The needs of the present time in a developing country such as Nigeria include all acts or processes of bringing about growth or advancement through successive stages to a higher more complex or more fully-grown state.

Some countries of the world like the United States of America. Russia and Germany have developed to the extent that they manufacture aircrafts carrying passengers and goods safely from place to place, whereas some other developing countries are at the stage of learning to repair or assemble motorcars. Some are yet to get to the stage of assembling bicycles. Every race naturally aspires to develop. The index of development could be determined by several capabilities of the country and these include: ability to provide basic amenities for her citizens, ability to defend the territorial integrity of the country, and ability to effectively manage her political, economic and social resources. It is in the light of these developmental factors and also the means through which development can be achieved that this paper is discussing mathematics and its teaching at the basic school level. Mathematics has always been seen as a factor in the development of a nation. The prosperity of any country depends on the amount and quality of mathematics offered in its school system. Without mathematics the understanding of national problems would be superficial and the way to

resolve certain problems of a nation is to actively encourage the use of simple mathematical models (Fajemidagha, 1986: Osafehinti, 1990). The relationship which mathematics has with society is best seen when one considers the stated objectives of basic education as they relate to mathematics. These were spelt out by National Mathematics Curriculum for basic school mathematics in Nigeria. These are:

I.   To acquire mathematical literacy necessary to function in an information age
II.   To cultivate the understanding and application of mathematics skills and concepts necessary to thrive in the ever changing technological world
III. To develop the essential element of problem solving, communication, reasoning and connection within their study of mathematics
IV.   To understand the major ideas of mathematics bearing in mind that the world has changed and is still changing since the first National Mathematics Curriculum was developed in 1977(NERDC, 2007).

There is need to incorporate such changes in the areas of Information and Communication Technology, Population and family life education, Environmental degradation, Drug abuse, HIV/AIDS. These gave rise to the need to make the curriculum more responsive to the survival and developmental needs of the Nigerian child.

School mathematics is invaluable to National development. The implication of such importance should be good teaching at all levels. Facts and rules in Mathematics should be derived from real life situation originating from societal problems, and its learning made interesting. Hence, there is need for project method of teaching mathematics to be incorporated in Nigerian schools.

The purpose of the Paper

Generally, the purpose of this paper is to explore ways through which good practices in the teaching of Basic School Mathematics in Nigeria may help to achieve the objectives of Mathematics teaching at school level and by implication. Set the country on the path of sustainable development in all spheres of life.

Specifically, the paper discusses:

I.   Current practices in Nigeria's mathematics teaching and how the various stakeholders in basic education have faired.
II.   Concept of Mathematics Project.

III.   A case study of education for sustainable development through mathematics projects among the 11 - 14year olds in a developed country.

IV.   Illustrations of project method application to broad topics in Nigeria's Basic School Mathematics curriculum.

Current State of Mathematics Teaching

Mathematics like science is a discipline, which demands intense concentration, connections to previous materials and a structured daily study plan outside the classroom. The problem of mathematics learning among students requires a creation of a better climate or environment for mathematics learning. All stakeholders in education are required to contribute to the process of achieving the objectives of mathematics teaching. The stakeholders include: the teacher, Students, parents and society in general. It is simply necessary that all stakeholders should work in concert to bring about sustainable development to society. How then have the various stakeholders faired?

The Teacher and Teacher Preparation

The supply of mathematics teachers is critically low not only at the upper basic school level but also at other levels of the education system of the nation (Awodeyi, 2004). Ibe (2003) and Inyang (2003) studied the quality of Mathematics teachers in upper basic schools towards societal expectations in the 21st century in Abia and Akwa Ibom States respectively. In Abia it was one qualified teacher to 533 students while in Akwa Ibom, it was one to 763 students. A qualified teacher is defined by both researchers as one having a minimum of Bachelor of Science Education (B.Sc. (Ed) or Bachelor of Education (B.Ed.) degree in mathematics. It is doubtful if the situation in other States of the country is significantly better. The dearth of qualified and competent teachers in mathematics has resulted in generalist teachers and non-mathematics teachers teaching the subject in schools with a resulting negative impact on student's attitude towards mathematics and achievement (Awodeyi, 2004).

The reasons that may be advanced for the present shortage in the supply of qualified mathematics teachers include: aging of the profession and the attraction of the increasing number of higher paying jobs in the Banking industry. Production industry and technology industry; existence of many mathematics teachers who have insufficient pre-service preparation to do a meaningful teaching; most mathematics teachers have insufficient mathematics preparation in the university either as a result of incessant strike actions by some university lecturers or due to outright lack of lecturers in certain disciplines of mathematics such as algebra, analysis, differential equations, mechanics, etc. It is true that many of our universities rely heavily on mathematics lecturers from other institutions other than theirs in

order to keep their mathematics department going (Awodeyi, 2004). This is true during the process of accreditation exercises for some courses in our higher institution. The resultant effect of this scarcity of lecturers is an overstretch of the few available professors and lecturers. Also there is inadequate funding of the university by government. Most of the existing universities generate less than ten percent of their annual budget our level of development is still such that the private sector has not been able to significantly assist the universities with grants-in -aid. Consequently, infrastructure is dilapidating in the university, and the production of Mathematics teachers for secondary schools in the university has suffered significantly (Awodeyi, 2004).

The Students

The large enrolment figure of pupils/students in the basic schools can certainly not be supported by the low turnout of teachers from the university. We should also not forget that too many of these students enter senior secondary school with poor attitudes and limited motivation for learning mathematics (Awodeyi & Harbour-Peters, 2000: Allfrey 2001). There are many reasons given for this situation. Unfavorable poor school experiences, inadequate prior achievement, authoritarian instructional model, view of mathematics as an unending list of rules and procedures to be memorized, attitude of teachers to mathematics teaching etc. These reasons are strong enough to necessitate the few teachers who are available in the secondary school to search for new ways of imparting mathematics into the pupils/students. Teachers need methods that are economical, and at the same time very rewarding. Except for few gifted children and children from perhaps mathematically literate homes, many students may continue to perform poorly in mathematics and also hate the subject. This is certainly not healthy for sustainable development of any nation. Pupils/Students therefore require a positive learning environment, an environment which will give room for improvement of pupils motivation and for improved counseling of pupils about their Mathematics learning.

The Parents

Parents and guardians are committed to the success of the school. Parents are working tirelessly supporting the teachers and the school to bring about success in pupils/students learning. In Nigeria, the schools have an organized Parents Teachers Association (PTA). At the national level there is the National Parents Teachers Association (NAPTAN). The Association at the school level is helping schools to build classrooms, hostels, laboratories and also provide resource materials (Awodeyi, 2004). At the national level the association has been a major pressure group influencing government policy for schools and other tertiary institutions. One can easily recall that in the national strike called by the Academic Staff Union of Universities

(ASUU) in past years, the National Parents Teachers Association was in the news mediating between the Union and Government. While one would say bravo to the Parents Teachers Association, the problems are overwhelming that teachers have to find new ways of teaching the subject so that all these efforts by parents are not in vain.

Other Stakeholders

Schools Board and School Administrators

Workshops provide the teachers the opportunity to acquire new skills for teaching mathematics especially, those topics in mathematics perceived as difficult to teach. Teachers also interact during workshops and in the process resolve problems of teaching the subject. My personal experience is that most school administrators do not encourage their teachers in this wise. It is also my experience that some schools are lucky to have a few good teachers among the many that are teaching the subject. Unfortunately, the other less experienced teachers would not avail themselves of such opportunities to attend the lessons of such good teachers and learn something new.

Business and Industries

Some industries in Nigeria are making efforts to motivate pupils/students' learning through sponsored quiz competitions. Prominent among such industries and business concerns are Cowbell milk, Nestle food drink, Cadbury and the Nigeria National petroleum company (NNPC), to mention just a few. These companies have good records of organizing quiz competitions among student in particular in the sciences and mathematics. The competitions have always been very interesting, motivating and successful. However, a lot is still required by big time industries who should give the schools and the universities grants in aid to produce enough teachers and good mathematics pupils/students for sustainable development. Teachers' role in this education business is so important that its production cannot be neglect.

Subject Associations

Subject Association such as the Mathematical Association of Nigeria is doing so much to improve the leaning of mathematics in the country. The Association has been able to write text books-the mathematical Association of Nigeria (MAN) mathematics series for schools at a time when good texts were scarce. At the junior secondary school level we have Jimmy/Musa Memorial Mathematics Competition. This Mathematics competition is sponsored by the Mathematical Association of Nigeria, not only to immortalize the name of late member, but also to bring about motivation towards improved performance of students in mathematics in

the school. These achievements by the Mathematical Association of Nigeria notwithstanding, the ground from where good harvest is expected has to be fertilized and watered. The fertilizer and the water are the teachers who must find better ways of teaching the subject to students for sustainable development.

The Mass Media

The mass media is generally called the watchdog of society. The mass media as a stakeholder has played significant roles in bringing to the generality of society activities of the school. Wide publicity has always been given to school activities such as the NNPC sponsored mathematics science and Technology quiz competitions, the young brains-a school science competition sponsored by Nestle, and many more. The entire proceedings at the competition have always been relayed live to Nigerians to the admiration of all and sundry. The mass media no doubt has performed creditably within its own limits. It is simply hoped that the teacher will find appropriate solution to students' poor attitude towards mathematics and to the dwindling performance of pupils/students in school examinations, so that there will be many more discoveries to exhibit among students.

MATHEMATICS PROJECT

A project may be regarded as a special form of take home examination, which provides for a topic to be studied as a greater depth than would normally be covered in the classroom. It may also be referred to as a long-term assignment to a student or group of students which involves the application of some skill learnt from a unit or unit of lesson to solve a real-life problem. A project may require the production of some material object and it is problem-oriented and trains the students in independent problem solving (Obodo, 2004).

A project in mathematics can be used in evaluating the psychomotor, cognitive and affective outcomes. A good illustration of a mathematics project has been aptly described by Harbor-Peters (1992) as follows. Project: Construction of a Geoboard for representing quadrilaterals.

Objectives: At the end of the project, the student should be to

I. Measure unit squares on a wooden board;
II. Affix nail accurately at the intersection of the squares;
III. Map out quadrilaterals on the board using rubber bands. Example of such quadrilaterals are squares, rectangle, rhombus, kite, parallelogram, trapezium

Description of the Project.

The Students should:-

I. Measure out and draw 2cm unit squares on a rectangular plywood board;
II. Affix nails at the intersections of the squares such that the distance between the nails will be uniform;
III. Use rubber bands to form the boundaries of the quadrilaterals.

Materials for the project

The Following Materials Are Required.

I. 225 (half inch nails) per student.
II. A small hammer for each student
III. A square board of length 32cm made of plywood.
IV. Rubber bands of different colours.

Skills To Be Assessed

The following skills should be assessed

I. Steadiness of hands in drawing the line
II. Outlay of the geoboard
III. Accuracy of spacing between the nails on the geoboard.
IV. Dexterity of hand in writing.
V. The position of the hammer (little effort is needed if the hand is placed further away from the fulcrum.
VI. Uniformity in the height of the nails.
VII. Control of wastage of the nails.
VIII. Accuracy in the use of the rubber bands in solving the various shapes.
IX. Accuracy of the shapes.
X. Neatness of finished project

These skill have been identified are now used in developing a rating scale as in section.

A RATING SCALE FOR ASSESSING LEARNING OUTCOMES FROM THE MATHEMATICS PROJECT

SKILL	Excellent	Very Good	Fair	Poor	Good

I. Steadiness of hand in drawing the lines II. Outlay of the geoboard III. Accuracy of the spacing between the nails on the geoboard. IV. Dexterity of hand in nailing V. The position of the hand on the hammer (little effort is required when the hand is further away from the fulcrum) VI. Uniformity in the height of the nail VII. Control of wastages in the nails VIII. Accuracy in the use of the rubber bands to indicate the various shapes IX. Accuracy of the shapes X. Neatness of finished product					

Key to scoring

Excellent	- Distinction	- 5 point
Very Good	- Credit	- 4 point
Good	- Merit	- 3 point
Fair	- Pass	- 2 point
Poor	- Weak	- 1 point

Other keys can be used:

Strongly Agreed (SA), Agree (A), Neutral (N), Disagree (D), strongly disagree (SD); Or

Very Satisfactory (VS), Satisfactory (S), Neutral (N). Unsatisfactory (U), Very unsatisfactory (VU)

These are 5-point scales. A four point scales can be used by excluding neutral in the above ratings.

A survey of the skill shows that the skill cut across cognitive, affective and psychomotor outcomes. For instant, skill number (iii), (iv) (viii), (ix) are cognitive while skill (i), (iv), (v), (vii) are psychomotor. Skill (i), (iv) and (vii) may be classified as belonging to the affective domain. Skill (i), (iv) and (vii) can only be rated in the process of carrying out the project while the rest of the skills can be evaluated at the completion of the project.

In other words, project can be utilized in evaluating the three domains and affords the mathematics teacher the opportunity to assess the learner and find out if he

I.   is positively disposed to carrying out the project with the others in the group (affective):

II.   has the necessary manipulative skills to cope with the project (psychomotor), and

III.   has acquired the necessary mathematics concepts and skill (cognitive).

Projects can be given to individual students or in groups. This depends on the nature of the project. In addition, group projects in mathematics give the teacher the chance to comprehend the implication of social relationships among learner of mathematics.

A TYPICAL CASE STUDY ON EDUCATION FOR SUSTAINABLE DEVELOPMENT THROUGH MATHEMATICS PROJECTS

The use of projects in facilitating mathematical learning for sustainable development is not new in the education arena. It has been found successful somewhere. Allfrey (2001) reported the success of a case study of education for sustainable development through mathematics projects. Her study involved 11-14 year olds. Her topics of study were 'population explosion' and 'oil spills' the duration of each project was four double lessons of 70 minutes each, Her methods were; leading the class for discussion and breaking up the class into group for specific assignments; the resources used were: student' booklets that outline the tasks and procedure, internet café far gathering and other publication relating to the project titles.

The procedure for the oil spills' project for 12 years old;

The project looked first at the environment impact of spilled oil through background reading and brainstorming to elicit existing knowledge. Each pupil then chose a particular incident to investigate in detail. Possible causes include tanker spills or crashes, pipeline failures, oil-field accidents, problems at refineries and wars. The work sheet made available to the pupils was such that enabled those present observed trends on graph and on pie chart .Discussion set for the pupils include identification of causes of oil pollution, and trend of pollution over time. Faster working pupils were encouraged to research further on the internet in order to acquire more in-depth understanding of the consequences for ecosystems.

Advantages derivable from the project can be categorized under the cognitive, the psychomotor and the affective domain of leaning. In the first place, pupils did not just learn about the mathematics side of the topic but learnt about the environment; pupils found the

project an enjoyable investigation to carry out; they also admire their work sheets which contain the frequency tables, and the pie chart constructed from the data.

The Nigeria mathematics teacher can borrow a leaf from the project described above and achieve education for sustainable development by re- organizing the scheme of work tv accommodate projects.

A LIST OF PROBLEM PROJECTS FOR NIGERIA BASIC SCHOOL STUDENTS

The primary and junior secondary school mathematics for Nigeria is divided into sub-topics viz: Number and numeration; Algebraic processes; Geometry and Menstruation; and Everyday Statistics.

Typical examples of project titles which may be obtained from some of this broad topic are listed below

1. **Number and Numeration**

   a) An analysis of the number of students in a local government who registered and passed the junior school Certificate Examination with Distinctions in all of mathematics and basic science ;in mathematics only, basic science only, .
   b) The project above borders on sets and Venn diagram for students in JS2. Students are bound to enjoy the project, and make value judgment on their findings. The mathematics teacher in the school can find out other suitable project titles on Number and numeration for students to work on.

2. **Algebraic processes**

An analysis of the performance of male and female students in the Junior School Certificate Examination (JSCE) in the local Government for the year 2011. This title has to do with linear graph for JS3 students.

3. **Menstruation and Geometry**

An analysis of the bricks, wood and iron sheets, which may be used to construct to specification a classroom block for the school, right from the foundation level to the roofing state (Windows and doors inclusive)

4. **Statistics**

An analysis of the consequences of pipelines vandalization in Anambra State, Nigeria, on Nigeria's social and economic life. This title is suitable for the JS3 student in statistics. The target of this project includes the determination of quantity of fuel in Naira lost by the NNPC in the incident. Quantity of drugs in Naira used in treating burnt victim. The numbers of people who died in the fire that broke out from the volatile oil when the pipelines were vandalized. The quantity of farm crops in Naira devastated in the fire outbreak. An estimate of sea animals that died because of spilled oil into the waters. Student should present data in the best statistical mode and make value judgment on the findings.

SUMMARY AND CONCLUSION

Students still dread mathematics and its learning at the Basic schools. The reason for this was traced to the early mathematics background of the pupils at the primary school level where teacher used authoritarian instruction model, and where they saw mathematics as an unending list of rule and procedures to be memorized. Pupils' problem with mathematics learning was found to be compounded at Basic level because there are only a few competent teachers to cope with large population of pupils. The Colleges of Education would not cope with the production of equitable number of mathematics teacher required for the Basic schools. A way out which may serve as a temporary measure was found. It is a method of teaching mathematics for sustainable development through mathematics project. Project method will enable a teacher to cope with a large number of pupils/students in limited time. The method of project takes care of the three domain of learning viz: the cognitive, the affective and psychomotor. A case study of education for sustainable development through mathematics project which involved children of ages 11-14, at Crispin school, Somerset, was discussed. The Crispin school case study was found worthy and it could be experimented in Nigeria or in other places with identical problem with Nigeria.

Based on the success of the Crispin school case study, the present work made attempts to coin out some project titles from the broad topics of the junior secondary mathematics curriculum (FME.2004).It is hoped that Basic schools mathematics teachers will try the project method for susstainable development of the Nation.

RECOMMENDATIONS

1. Mathematics teachers at the basic school should try the project method in their various schools.
2. Data can always be gathered about projects by visiting internet cafes in the neighborhood of the school. Where internet cafe may not be found useful, school

boards and school administrators should encourage pupils/students excursions to industries and other relevant places for collection of data for projects.

3. Mathematics in schools requires the support of all, particularly the school is board and administrators, business and industries, subject associations and the media.

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