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## INTEGRATING MATHEMATICS AND OTHER DISCIPLINES IN NIGERIA: A STAND FOR CURRICULUM REFORM

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***Abstract:** The application of mathematics knowledge and skills in all facets of human endeavour calls for integrating the subject with other disciplines. It is likely to bring out the usefulness of mathematics more glaring in teaching and learning situations and application in real life situations. The paper discusses integrating mathematics with other disciplines in Nigeria to facilitate appropriate solution of societal problems. The paper further analysis the integration of mathematics and other disciplines in Nigeria and points out how much is needed to be done. The relationship between mathematics and other disciplines is clearly brought out to cover all human fields of study and work including agriculture, material science, among others. The need for curricular reforms in Nigeria is stressed. It is therefore suggested that curriculum developers should try to close the gap existing between mathematics and other disciplines for effective application of mathematics to ensure socio-economic, scientific and technological development among others. The method used in teaching should be experiential with well trained teachers.*

**Keywords:** Integration, Mathematics, Other Disciplines, Nigeria, Curriculum Reform

### Introduction

Mathematics has been the basis or a vital tool for the development of civilization throughout the world from ancient to the modern times. Due to fundamental and necessary advancement of knowledge especially in science, engineering, technology, life sciences and social sciences the importance of mathematics becomes imperative. Advances in mathematics have therefore been driven by efforts to solve difficult problems which necessitate the development of new theories and modelling which enables the application of mathematics to take place in all human work and study. According to Monastyrsky (2001) often the solution of a concrete difficult problem necessitates the creation of a new mathematical theory while on the other hand; the creation of a mathematical theory may lead to the solution of an old classical problem. This implies that the application of mathematics in solving a wide range of problem is indispensable. Today the application of mathematics in the sciences such as information sciences and information technology, Bio-medical Engineering, Bio-technology and social sciences such as Economics among others worldwide are some of the leading pursuits (Mohan, 2012). This trend necessitates the need for integrating mathematics with other disciplines since mathematics is the language and tool for scientific and technological development as well as all in facets of human endeavour.

In Nigeria as it is elsewhere education is considered as the key to national development. It therefore rests on the curriculum developers, mathematicians and mathematics educators to make serious efforts towards integrating the teaching and learning of mathematics to all disciplines in schools at all levels. This may foster the culture of application of mathematics in all life situations by the citizenry and ensure national development. This paper examines the concept of curricula integration, the Nigerian context, Relationship between mathematics and other disciplines, the need for integrating mathematics with other disciplines Reform challenges and prospects of curricula integration in Nigeria. The paper then provides suggestions for effective integration of mathematics with other disciplines. It is hoped that this paper may serve as an eye-opener to curriculum developers and implementers in the nation's education systems. This is likely to gear the efforts of the nation towards socio-economic, scientific and technological development. This implies that the reform will change the attitudes, efforts and determination of Nigerian citizenry towards acquiring mathematics knowledge, thinking, reasoning and process skills for application in real life situations. They can use such knowledge and skills to create products and services thus creating jobs instead of remaining job seekers where there are no jobs.

### **The Concept of Curricula Integration**

Integration here refers to the teaching and learning of mathematics with its application to other fields of human work and study. Beane (1995) defined curricula integration as a way of thinking about the purpose of schools, success of curriculum and the basis of knowledge. Beane believes that curricula integration must take into account the basis of knowledge. Here also the purpose of schools is the function of curricula implementation. Thus today as Nigeria aspires for scientific and technological development and mathematics being the basics of science and technology the integration of science, technology and mathematics and other fields of study becomes imperative. According to Koirala and Bowman (2003) integrated curricula delivery provides opportunities for more relevant, less fragmented and stimulating experiences for learners.

Robutson (1994) in Fumer & Kumar (2007) gave a list of considerations necessary for interdisciplinary instruction such as an understanding of the nature of the subject field involving a single teacher or multiple teachers or multiple teachers and a deeper knowledge of methods of interdisciplinary subject matter correlations, among others. This implies that educators will acquire the knowledge of a unified subject field, say mathematics and physics, chemistry and economics, among others. This necessarily requires matching subject themes, topics and has to be problem solving orientated. Beane (1992) suggested moving away from single subjects approach to identifying a central theme and to look for what each subject area can contribute to it. For example the concepts of mean, ratio and proportion can be applied to problems in say, physics involving, measurement of forces, pressure, velocity, calorimetry, among others. Thus the integration of mathematics and physics is likely to increase students' achievement in both subjects. This relates to constructivists approach of minds-on and hands-on learning

approach. It must be recalled also that integration of mathematics and other fields goes beyond mere use of mathematics knowledge and skills as explained by the theory of transfer of knowledge. It involves using mathematics as tool to create new knowledge, ideas and products.

### Examples of Curricula Integration

At this point it is necessary to consider some examples of curricula integration in some parts of the world. Integration of school subjects and mathematics curricula has become the major consideration in most countries of the world especially the developed countries. For example, in America, organizations such as the National Council of Teachers of Mathematics (MCTM) (2000), School Science and Mathematics Association (SSMA, 2000) and the National Science Education Standards (NRC, 1990) have worked out curricula document and standards for the integration of mathematics and science curricula. In France, Dorler (2006), emphasised one important feature of changes in school curricula as a global reform to foster inter-relations between different subjects. He pointed out that projects have been introduced at different levels of education such as *Itinéraire Dè convertes (IDD)* and *Travoux Personels Encardres (TPE)* are projects carried out by small groups of students involving correlation between at least two different disciplines. Dorler further illustrates examples of connections of mathematics and physics, economics and industrial production management, economics and other social sciences. The tool employed in the solution of human problems in various fields has been the mathematical modelling. In other developing countries such as India the story is the same (Mohan, 2012). This explains why some countries are developing more significantly than others. One is likely to ask: What is happening in Nigeria?

### The Nigerian Context

Currently Nigeria has developed a mathematics curriculum for both General Mathematics (GM) and Further Mathematic Curriculum (FMC) at the secondary school level. The GM may serve more specifically those students intending to read social sciences and education courses while the FMC is for those students intending to read the sciences, engineering and technology courses at higher institutions of learning. The higher institutions are given the opportunity to develop and use the appropriate curricula. The secondary school mathematics curriculum document specifically points to the application of mathematics in other fields of study. For example, the concepts of indices and logarithms are directed for application in areas of economics, geography and science. (Federal Ministry of Education, FME, 1985). The document, however, is silent about other themes or topics and their areas of applications in fact all aspects of mathematics can be applied in one real life activity or the other. There is need for the document to be more comprehensive with precise directives as to what central theme in mathematics can be applied to other areas. It is only then that students can effectively utilize mathematics for national development. Attesting to the above fact Iji (2002) pointed out that scientifically and technologically an illiterate person is considered circumscribed in playing his or her full role in the socio-economic development of her nation. It is only through proper training of her citizens

that Nigeria can achieve her developmental aspirations. In essence Nigeria recognizes the necessity for curricula integration. However, the implementation of the curricula, teachers teach mathematics and other disciplines as distinct unconnected disciplines. For example, mathematics is used in all aspects of physics but taught as if they can hardly be connected. For instance vectors is defined in mathematics as a quantity having magnitude and direction with algebraic properties while in physics magnitude is the only consideration and treated with geometric properties. That is, concepts in mathematics are not fully brought out to bear on the concept of other fields in the teaching and learning classroom situation. Teachers teach the way they were taught.

### **Relationship between Mathematics and other Disciplines**

Mathematics can be applied in all facets of human endeavour. Some of the areas of application are discussed as follows:

#### **Mathematics and Agriculture**

Agriculture involves the production of farm produce, rearing of animals, poultry, fishery, among others. All these ventures require proficiency in the knowledge and skills in mathematics to succeed whether the production is for consumption or for commercial purposes. The graduates of mathematics and other – fields can use the combined knowledge to produce animal feeds, mix chemicals for the production of fertilizers based on the type of farm soil, compute input/output ratio and profit. The mathematics concepts of ratio, proportion and percentages, among others, are relevant in this quest. With increased yield and proper management more school graduates will be self-employed. Thus the problem of unemployment will be reduced, Nigeria will reduce the importation of food items, have enough raw materials for agro-allied industries, increase employment rate and conserve more funds for other developmental projects.

#### **Mathematics and Material Science**

In the face of soaring unemployment Nigeria needs integration of mathematics and material science to create jobs and not for graduates to seek jobs. Material science can be described as a method of synthesis and manufacture and modification of materials, the understanding and prediction of the properties of materials. It is essentially concerned with the experiential study of ceramics, plastics and metallurgy depending on the physical sciences, mathematics and engineering (Masanja, N.D). The tools of mathematics used include functional analysis, partial differential equations and numerical analysis. The undergraduate and post-graduate students can be exposed to this area to create small business venture including the production of beer cans and cosmetics among others.

#### **Mathematics and chemistry and Physics**

The relationship between mathematics and physics is that of mutual co-existence. In chemistry too there exists a lot of mathematical applications such as mixtures, chemical reactions and rates of change, among others, in all these themes the mathematical concepts of derivatives, integration, ratio, proportion, equations and percentages, among

other, are used. These may have direct application to practical issues relating to manufacturing industries and medicine.

### **Mathematics in Biology and Medicine**

Mathematical models have become imperative for its effective study and application in Biology and Medicine. For example The kidney which contains one million tiny tissues (nephrons) are responsible for the transpiration of salt to the kidney by osmotic pressure and filtration Masanja (n.d) points out that Biologists have identified the body tissues that are responsible for this process. He adds that a simple mathematical model helps to determine the formation of urine and the decision of the kidney on the amount of urine to excrete or retain. The mathematical models used employ Partial Differential equations, fluid dynamics, among others. Anyor, (2013) discussed using exponential functions for drug administration including the treatment of wounds. Thus mathematics is an essential tool for ensuring the health of the populace for a healthy economy and hence national development.

### **Mathematics and other Disciplines**

In other areas including Digital Technology, number theory, dynamic, Partial Differential Equations, numerical analysis are key mathematical tools used. Also in the Army and other law enforcement agents concerning defense rely on mathematical modeling concerning architectural issues, mobile communication systems and the like. Probability, stochastic analysis and mathematical sensing models are among the mathematical tools used. The list is not exhaustive, suffice it to have the above examples. From the foregoing it becomes clear that mathematics is fast developing to assist in discoveries and innovations in basic science, engineering, technology and the life sciences. This shows that every area in mathematics is essential in all human endeavour. These examples illustrate the fact that the developments in mathematics pose a significant challenge to mathematics curricula in Nigeria as could be elsewhere. The focus of this challenge is on curriculum document and materials as well as teacher preparation and pedagogy to foster inter-disciplinary approach and research.

### **The Need for Integrating Mathematics and Other Disciplines–Curriculum Reform**

The acquisition of Mathematics knowledge and skills reinforced by the powerful tool of mathematical modeling make it possible for advancement in all human endeavour. Nigeria aspires for socio-economic, scientific and technological development which depends highly on mathematics. Nigeria has a lot of problems to solve including internal political and religious problems, eradication of poverty, health delivery, national defense and security, unemployment and the problems of industrialization among others. As exemplified earlier in this paper, advancement in mathematical skills, knowledge and mathematical modeling may provide a sure panacea to the problems the nation is facing. Thus integrating mathematics and other fields of work and study may move Nigeria to compete favourably in the competitive global advancement in science and technology in particular and the knowledge world in general.

### **Prospects of Curricula Integration**

For teachers to adapt changes or innovation has always met with resentment. This could be because teachers do not know how to go about the necessary requirements for the change or that they consider the change as in- appropriate. Others may strive earnestly to adapt the change and produce the desired results. Pyke & Lynch (2005) reported a study they carried out with mathematics and science teachers that integrative instruction increased students' achievement in both areas of study. The integration of mathematics and science units motivates students (Wolfe 1990) and raises students' achievement in both fields of study. Technological advancements in user-friendly software give support for integration of instruction in line with curricula objectives, such software's include Arc-View-Geography Information System (GIS) and SimCity are two programs that connect mathematics, science and social sciences concepts (Furner & Kumar, 2007). Widely used in developed countries is the Berlin & White (1992) CP-RDM database integration of science and Mathematics Curriculum material unit prepared lessons. There exists the "Great Explorations in Mathematics and sciences" which are activity books for students at all levels of education among others. The internet provides a world wide web of research and acquisition of such knowledge in schools and homes. Teachers and students should take advantages of this facility. Curriculum planners can take advantage of the facilities for a sound curriculum integration

### **The Need for Teacher Training Reform**

It should be recalled that the teacher is at the centre of curriculum development and implementation. It is the teacher that is responsible for curricula success and the attainment of national goals. Thus if Nigeria is to attain the MDG and the NEEDS goals then there is no amount of money and time spent for training of teachers would be fruitless. Teachers must be trained in the multiple disciplinary knowledge, skills and applications of mathematics to solve real life individual and national problems. The development of softwares and computer application makes the integration and teacher training process a sure success. The training must include pedagogical consideration and the use of modern technologies for effective teaching and learning.

### **Suggestions**

1. The Nigerian, curriculum developers should close the cultural gap existing between mathematics and other subjects as well as subject teachers towards effective training of the citizenry for effective application of mathematics for socio-economic, scientific and technological development.
2. Modeling in mathematics lends itself to application in all human endeavour. Hence the art of mathematical modeling should be made compulsory at all levels of education considering learners age, and level of education.
3. Curriculum materials as outlined in prospects of integration above should be adopted and reviewed to meet Nigerian needs. Teachers should be trained in the use of these materials for effective and efficient teaching and learning.

4. Since it may not be possible for a mathematics teacher to study all other subjects, it is suggested here that all mathematics teachers be trained in at least one other subject say chemistry, with application.
5. Books should be written to reflect integrative culture of teaching and learning of mathematics with application to other disciplines.
6. The method of teaching will inevitably be the collaborative (team) teaching where applicable.

### Conclusion

In Nigeria as could be elsewhere, parents, guidance and students are asking questions as what is schooling for. This type of question arises because of the orientation that schooling is for attainment of jobs for a living. Now that the rate of unemployment in Nigeria is sky-rocketing the study of mathematics with its application in a wide range of real life situations including the possibility of creating jobs instead of taking jobs, should be pursued with vigour and sincere commitment. It is therefore essential that the integration of mathematics with other disciplines is a sure way of solving problems related to socio-economic, scientific and technological development of the nation and should be pursued vigorously.

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