MATHEMATICS EDUCATION AND NIGERIA'S ECONOMY BEYOND OIL, IMPLICATION FOR MATHEMATICAL MODELING.

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Abstract

Nigerian economy, being an oil-driven economy, requires mathematics in order to effectively put science and technology in the front burner of national development. Many developmental and economic challenges currently facing Nigeria as a Nation, could be solved, if and when mathematical modelling is used to describe and analyse such problems. A mathematical modeling is a process of representing real world problems in mathematical terms in an attempt to understand and find solutions to the problems. In this paper we review the role; mathematical modeling can play in helping Nigeria's economy to be diversified beyond oil. Processes of mathematical modeling were highlighted. Some applications of mathematical modeling were equally examined. It was found out that mathematical modeling is one of the tools needed to transform the Nigerian economy from a developing to a developed economy. From the review, it is recommended that the Nigerian Government should invest more in mathematics education at all levels – primary, secondary and tertiary – in order to train more mathematical modelers and provide the enabling environment for the teaching and learning of mathematics. Again, students should be motivated or encouraged to study mathematics in general and mathematical modeling in particular, through grants, loans and scholarships.

Introduction

The Nigerian economy, being a developing economy, requires mathematics in order to effectively put science and technology in the forefront of national development beyond oil. Mathematics has always been seen as a factor in the development of a nation. The prospect of any country depends on the volume and the quality of mathematics offered in its school system. Mathematics therefore, is an interdisciplinary language which explains the relationships, structures, quantities, properties and forms of objects, constructs, time and space. Mathematics as a subject cuts across all areas of human learning and endeavour. An effective learning of mathematics is therefore, imperative, for a society to cope and compete effectively in the present world of fast changing scientific and technological development. This explains the fact that knowledge gotten from mathematics is applicable to all areas of human activities and consequently, determines the level and rate of national development (Iji, 2010). According to Odili (2006), the objectives of teaching mathematics include; to generate interest in Mathematics and provide a solid foundation for everyday living, to develop computational skills; to foster the desire and ability to be accurate to a degree relevant to the problem at hand; to develop and practice logical and abstract thinking; to develop ability to recognize problems and to solve them with related mathematics knowledge; to provide necessary Mathematical background for further education and to stimulate and encourage creativity.

However, rapid development of information and technology today has changed society's expectations form people and education world. Today's world expects mathematics teachers to raise individuals who are able to create effective solutions in cases of real problems and use mathematics effectively in their daily lives. Thus, they will enjoy mathematics instated of being scared of it and comprehend and appreciate the importance and power of mathematics (Doruk , 2011). This process of development and change caused new searches in our educational system and it became compulsory to try new approaches, methods and models in the educational realm. One of those new approaches in mathematics teaching is teaching by means of models. According to Peser (2008) models are concrete entities, pictures and objects in which some states of a concept desired to be developed are represented. Students are very interested in this approach. The main reason why mathematics is the most comprehensive education area of the world is that mathematics could be used in various ways in areas and topics that is not related to it. Mathematics is always used outside itself, in a covered manner or clearly especially in cases of problems, situations or areas including mathematical models and modeling (Niss, 2012). According to Heuvel-Panhuizen, (2003).

Mathematics is not a closed system or a subject that should be learned but a human activity and it has to have a relation with the reality.

In educational settings, mathematical modeling has been considered a way of improving students' ability to solve problems in real life (Gravemeijer & Stephan, 2002; Lesh & Doerr, 2003). In recent years, many studies have been conducted on modeling at various educational levels (e.g., Delice & Kertil, 2014; Kertil, 2008), and more emphasis has been given to mathematical modeling in school curricula (Ayla, 2015).

The term "modeling" takes a variety of meanings (Kaiser, Blomhoj, & Sriraman, 2006; Niss, Blum, & Galbraith, 2007). It is important for readers who want to study modeling to be cognizant of these differences.

The term mathematical modelling may mean the process of model building, leading from a real situation to a mathematical model, or the whole applied problem-solving process, or again any manner of connecting the real world with mathematics. In recent years, the term applications and modelling is frequently used as an all-embracing expression for the various interrelations just mentioned.

Today, modelling is favoured by almost everybody, as are problem solving, active learning and other activities of this nature. There are various reasons for favouring modelling in mathematics teaching. This includes four essential arguments, based mainly on general goals and aims for mathematics instruction (Blum, 1991).

Pragmatic arguments. Mathematics teaching is intended to help students to understand and to cope with real-world situations and problems. To that end, modelling is indispensable.

Formative arguments. By being concerned with mathematics, students should - we hope - acquire general qualifications (such as the ability to tackle problems) or attitudes (such as openness towards new situations). Modelling is one important way to develop these.

Cultural arguments. Students should be taught mathematical topics as a source for reflection, or in order to generate a comprehensive and balanced picture of mathematics as a science and a part of human history and culture. Modelling is an essential feature of human intellectualism as well as of history and of actual practice, and can thus contribute towards promoting those aspects.

Psychological arguments. Mathematical contents can be motivated or consolidated by suitable modelling examples, and these may contribute towards deeper understanding and longer retention of mathematical topics, or they may improve students' attitudes toward mathematics.

MATHEMATICAL MODELING PROCESS

Modeling process is defined in the program as a process "that is completed by mathematizing the mathematical modeling problem starting with a real life problem and interpreting the results that is obtained for real life". It is underlined that importance is given in the program to the creation of learning environments based on problem solving in order to develop modeling skills of the students. Blum and Ferri (2009) showed the cycle of the modelling process in 7 steps given below in order to help the cognitive analysis of the modeling situations, which they also used in their projects. Mathematical expression of a problem and the process of solving this problem by putting real life aside are shown in a cyclic manner in these steps.

1. Understanding the situation (problem)
2. Simplifying/structuring
3. Mathematizing
4. Mathematical working
5. Interpretation
6. Verification
7. Presentation

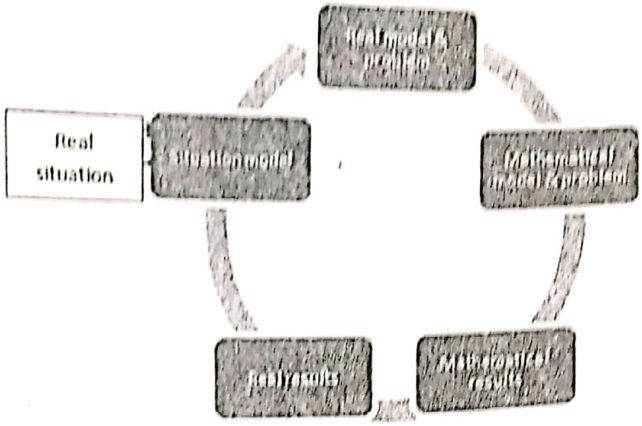

Figure 1. Modelling Cycle: (Ferri, 2006)

Situated in contexts, Mathematical Modeling provides methods for analyzing data, formulating theories—often expressed in symbolic mathematical forms—and testing those theories as well as helping with contextualizing problem- solving processes which could be used in diversifying the economy without relying on oil.

Therefore, the process of Mathematical Modeling can be exercised using various learning settings; from deductively arranged authentic problem modeling activities (English & Sriraman, 2010) to inductively organized inquiries leading the learners to formulating general patterns (Sokolowski & Rackly, 2011).

Due to being context driven, knowledge acquisition by the processes of modeling plays a vital role in developing students' skills not only in mathematics classes but also in other disciplines, especially in sciences (Lesh & Harel, 2003). Confrey (2007) claimed "the strongest arguments for modeling are based on the view that it will be advantageous for the development of students' thinking" which is being accomplished by shifting the learning focus from finding unique solutions to enhancing skills of developing general solution processes through transforming and interpreting information, constructing models, and validating the models (Lim, Tso, & Lin, 2009).

Through these processes, students learn mathematics to "develop competency in applying Mathematics and building mathematical models for areas and purposes that are extra- mathematical" (Niss, Blum, & Galbraith, 2007). This orientation requires the teacher to guide the students generally through Mathematical Modeling processes, not to provide direct solutions.

Contributions of Mathematics Education to Economic Development in Nigeria

Mathematics is such that its contribution goes beyond only sciences but also in other fields of human endeavour. In social science for instance, it had taken a centre-stage in the fields of economics, sociology, psychology and even political science. This comprises of country's socio-political and economic conditions whose indices rely on mathematics for policy execution after they must have been outlined, sketched and set in motion. Viewing this from global perspective, Woodrow (2003) posited that: "Mathematics has a peculiarly special position in the social and political discourses across the world – to put in such use, in our now dangerous world, holds global significance. As the 'language of science' it had long assumed power and influence as the terminology of science but during the last half century it has permeated many of the social sciences, including not only economics but also such social areas of debate as wealth distribution (poverty and affluence) or crime and its causes and consequences. Mathematics is initiated into political/social debate as a contribution to the conduct of rational debate – much as forensic science has become recognized in crime detection – fuelling and being fuelled by the 'myth of cold reason' (Taylor, 1996). It has been used in this form within 'economics' during its rise to political prominence. Economists use mathematics not to formulate, nor to theorize, but essentially to describe their world.

They thereby invoke all the security and certainty that is embedded in popular conceptions of mathematics but with no axiomatic basis and little predictability. Yet by the use of mathematics as the language of 'the market' so mathematics has become entwined and identified with market economics" It can be seen by the foregoing that mathematics is inseparable from economic

veloph ... as it has been used to drive centuries-old policies of the world. Society viewed athematics as the foundation of scientific and technological knowledge which is considered vital in ie socio-economic development of the nation (Mbugua, Kibet, Muthaa & Nkonke, 2012). For a ountry to fully harness its ever growing socio-economic needs, the need of knowledge acquisition mong its citizenry has to be cogent. In a country's financial market for instance, all the models to be eveloped are governed by mathematics (Stuparu & Daniasa, n.d), as such mathematicians have to e groomed to work in close partnership with the financial institutions, in order to develop such nodels. However, in Nigeria, even before the advent of formal education, mathematics was used in aking the daily stock of trading and farming activities (Aguele & Usman, 2007). They further maintained that in most rural societies, the basic phenomenon of counting numbers, in either base five or twenty, was in popular use till date. Ultimately, this gave rise to market day's phenomenon and counting system in the society.

Contribution of Mathematical Modeling to Economic Development and Sustainability in Nigeria

The role of mathematical modeling in Nigeria's economy and the path of sustainable development in this 21st century cannot be over emphasized. Mathematical modeling is one of the tools needed to transform the Nigerian economy from a developing to a developed economy beyond oil. Traditionally, application of mathematics had been restricted to the physical sciences, and the theories in the social sciences had been neglected, but in modern days we notice that mathematical economics is flying high. We also observe that the articles on mathematical economics and fewer points on economic theory, occupy more prominent place in the economics' journals. Economic development and sustainability on the other hand are two interwoven concepts, each showing how it could be used to reach economic growth in the country. For one, economic development can be put in jeopardy if it has not been made to be sustainable. On one hand, in an attempt to define development from economic point of view, Fatima (2014) considered it to be a process of economic and social transformation which is based on cultural and environmental factors and how they interact. In the same vein, sustainable development could be attained according to Isa, Jimoh and Achuenu (2013) through critical assessment and harnessing all country's growth indices. To this end, sustainability in the economic indices is achievable through carefulness in harnessing the resources, at the disposal of the country. One of such indices considered in economic development is human resources. In this regard therefore, sustainable development was described as the process whereby individual's capacity is being enhanced to create and consume wealth on lasting basis (Meena, 2014). She goes further to maintain that it encompasses among others socioeconomic, political and cultural environment in which people live and sustain the process. Furthermore, Eniayeju (2014) stressed that to ensure human capacity building in any society; which in itself could be considered as an economic strength of a nation, education of the citizenry must focus on four elements of sustainability. These four elements were reported by Okebukola (2007) as environmental sustainability, economic sustainability, social sustainability and political sustainability. To ensure economic development and sustainability, these development indices have to be made visibly executable. For instance, the environment in which the economic policy would be executed has to be made conducive and social justice among the citizenry has to be ensured as well as sustainable political atmosphere.

Conclusion

Based on the findings, Nigeria's economy can be diversified beyond oil given Pragmatic arguments which state that Mathematics teaching is intended to help students to understand and to cope with real-world situations and problems. To that end, modelling is indispensable. And Formative arguments. By being concerned with mathematics, students should - we hope - acquire general qualifications (such as the ability to tackle problems) or attitudes (such as openness towards new situations). Modelling is one important way to develop these.

In conclusion, Nigerian Government needs to invest more in mathematics education at all levels primary, secondary and tertiary – in order to train more mathematical modelers and provide the enabling environment for the teaching and learning of mathematics. This is because many

developmental challenges currently facing the Nation could be solved provided mathematical modelers empowered and allowed to describe them. Also, students should be motivated or encouraged to study mathematics in general and mathematical modeling in particular through grants, loans and scholarships.

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