



Mathematics in Contemporary Societies: An Effective Tool for Achieving the Vision 20:2020 Agenda

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Abstract

The value of mathematics to individuals and societies has, through the years, been well explored and documented. Mathematics boasts direct benefits to individuals and groups as well as scientific and technological spinoffs that better larger society. This paper examines Vision 20:2020, mathematics, and ways in which mathematics can foster the development of individuals and groups and its attendant effect on society at large. This paper highlights the suitability of mathematics as an effective tool for achieving Vision 20:2020. Finally, this paper suggests a number of next steps that will help to develop mathematics so as to achieve the nation's economic, scientific and technological goals.

Keywords: Mathematics, Vision 20:2020, Society, Development.

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INTRODUCTION

Both the International Monetary Fund (IMF) and United Nations (UN) provide a ranking of world economies as measured by Gross Domestic Product (GDP). In the IMF ranking, Nigeria occupies the 31st position and in the UN ranking, it comes in at 30th. According to the United Nations Development Assistance Framework 2009-2012 (2008), in the world economy Nigeria ranks 40th based on its GDP. Owing to good fiscal policy, a concerted fight against corruption, and growth in democracy over the last three years, Nigeria has moved nine places upwards in such rankings (Mordi, 2012). As noted by Mordi (2012), development in education (including science, technology and mathematics education) is listed by Goldman Sachs as an important stimulus for economic growth. Current government policies aimed at further reducing corruption and encouraging openness in trade must be accompanied by effective Science, Technology and Mathematics (STM) education if the country is to achieve Vision 20:2020. There is growing evidence of a correlation between global rankings in STM achievement and world economy rankings. As reported in The Guardian (2010), the world's ten largest economies have the following rankings in STM achievement:

Table 1: First Ten World Economies

Economy By Size	Rank in Achievement of STM
US	20 th
China	1 st
Japan	11 th
India	Not available
Germany	23 rd
Russia	46 th
Brazil	56 th
UK	28 th
France	25 th
Italy	32 nd

World Ranking in STM Achievement. Source: The Guardian (2010)

Nigeria did not rank among the ten largest economies as listed above. There is an urgent need for mathematics to assume a more central role in economic and technological development given its widespread application in all areas of science, technology, industry and commerce. As noted by Osafehinti (1990) and Aminu (1995), a society that aspires to be scientifically, technologically (and economically) developed must have an adequate level of mathematics education since math is the ingredient for the effective articulation of the abstract elements of science that give impetus to the development of new technologies. Given this and the nation’s aspiration to become one of the 20 largest economies in the world by 2020, that is, eight years from now, it is more important than ever to explore the knowledge and skills that can be provided as a result of mathematics education across Nigeria.

With the above remarks in mind, this paper examines Nigeria’s Vision 20:2020, mathematics, and the suitability of mathematics as an effective tool for achieving Vision 20:2020. This paper also highlights a number of steps that will help to develop mathematics so as to achieve the economic, scientific and technological developments required by Nigeria Vision 20:2020.

NIGERIA VISION 20:2020

Nigeria Vision 20:2020 (NV20:2020) is Nigeria’s long term development goal designed to propel the country into the top 20 world economies by 2020. NV20:2020 is a national effort aimed at growing and developing Nigeria, Africa’s most populous nation and bringing it into the league of the world’s best performing, and well-developed, economies (FRN, 2010). According to Bolarin (2010), NV20:2020 can be seen as a perspective plan: NV20:2020 has to do with awareness of Nigeria’s potential to become one of the 20 largest economies based on its abundant human and natural resources. NV20:20 is a laudable and ambitious programme, given Nigeria’s current status as a third world country. The Federal Republic of Nigeria acknowledged that attainment of the vision would enable the country to achieve a higher standard of living for its citizen. The NV20:2020 was developed by Nigerians for Nigerians and involved a process of thorough engagement with stakeholders across all levels of government and society. The vision is thus a rallying point for Nigerians, regardless of ethnicity, political leaning, economic status or religion and speaks to a desire to place the country on a sustainable development path and enable it to play a greater role in the comity of nations. The two broad objectives of NV20:2020 are to:

- Make efficient use of human and natural resources to achieve rapid economic growth;
- Translate this economic growth into equitable social development for all citizens.

The success of the programme will be measured by its ability to meet the following key parameters set by government:

- **Macro-Economy:** A sound, stable and globally competitive economy with a GDP of not less than \$900 billion and a per capita income of not less than \$400 per annum.
- **Agriculture:** A modern technologically-enabled agricultural sector that fully exploits the vast agricultural resources of the country, ensures national food security, and contributes to foreign exchange earnings.
- **Health:** A health sector that supports and sustains life expectancy of not less 70 years and reduces to the barest minimum the burden of infections and other debilitating diseases.
- **Education:** A modern and vibrant education system that provides the opportunity for maximizing potentials, and adequate and competent manpower.
- **Infrastructure:** Adequate infrastructure services that support the full mobilization of all economic sectors.
- **Manufacturing:** A vibrant and globally competitive manufacturing sector that contributes significantly to GDP with a manufacturing value added of not less than 40%.

MATHEMATICS DEFINED

Mathematics is the language of science, an essential ingredient in thought, logic, reasoning and therefore progress (Aminu, 2005). Obodo (2000) presents mathematics as a language that uses carefully defined terms and concise symbolic representations which add precision to communication. According to him, the language of mathematics is systems of sounds, words and patterns which are frequently used in communicating mathematical ideas and other related materials. Aminu (2005) views mathematics as the study of numbers and numeration systems, symbolic language, shapes, sizes and spaces, patterns, and the science of shapes, sizes, spaces, generalization, measurements and relationships. In effect, mathematics is a functional tool needed in every aspect of life and work. The functional role of mathematics to science, technology and national development is, according to Kurumeh (2007), so multifaceted that no nation can advance scientifically and technologically without mathematics. The industrial and technological development of any country thus rests on its ability to utilize the knowledge of mathematics (Odiri, 2006).

MATHEMATICS IN CONTEMPORARY SOCIETIES

Mathematics is no longer confined to being just an abstract subject; rather it has transcended the boundaries of solving scientific problems, designing industrial projects and facilitating business transactions. The role of mathematics in contemporary societies includes, but is not limited to, architectural design, bridge, dam and highway construction, and the description of various phenomena both in physical and economic situations through the use of concepts like shapes, sizes and quantity. Other areas of usefulness include the art/social sciences, religion, mysticism, commerce, war, information and communication technology, sports and pastoral life. According to Obodo and Harbour-Peter (1988), technological development is impossible without mathematics. Obodo and Harbour-Peter also contend that mathematics encourages the cultivation and practice of science virtues such as prudence, diligence, justice, patience, perseverance, cooperation, patriotism, objectivity and honesty. Adetula (1986) avers that mathematics is pervasive in today's world and is vital to an individual's meaningful and productive life. Further, outstanding ability in the subject should be seen as a precious societal resource critical to maintaining leadership in a scientific and technological world.

Given that mathematics is central to economic, scientific, technological, and societal development, it is worth examining some specific areas where math will positively affect the achievement of Nigeria Vision 20:2020. Among these are:

1. **Science and Technology:** Mathematics is the foundation of science and technology. It is required in integrated science as well as in Physics, Chemistry, Biology, and Engineering. Scientific knowledge is fundamental to addressing the critical issues of economic transformation and globalization, unemployment, poverty, hunger, disease and the sustainable use of national

resources. Mathematics is an indispensable tool for the transforming technological developments into reality as technology development represents the expansion and improvement in goods and services emanating from the practical application of science.

2. **Medicine:** Mathematics is also central to medicine. Functional numeracy is as essential to an aspiring medical professional as functional literacy. Mathematics skills needed in medicine include basic mathematical knowledge sufficient to calculate drug doses and concentrations, an understanding of the core statistical concepts most commonly represented in the medical literature, an understanding of algebra to ascertain calculations of acid-base status, and an ability to appreciate whether or not results are mathematically plausible. The logical reasoning required for the study of mathematics is an essential component of clinical reasoning.
3. **Economy:** Nigeria's economy is highly dependent on earnings from the sale of crude oil which accounts for 77% of government revenue and 95% of the country's foreign exchange earnings. Crude oil production is estimated in millions of barrels/day and is worth billions. The growth rate of real income per capital averaged uses percentages for calculation. The Gross Domestic Product (GDP), a primary indicator of the economic health of a country, is obtained by dividing the total naira value of all goods and services produced over a specific period of time. Decision making, budgetary allocations, fiscal policies and planning, and the equitable distribution of goods and services in different zones of the country all depend on statistical parameters and inferences.
4. **Agriculture:** Agriculture provides a country with the food essential for its nutritional development. The number of crops to be planted and the amount of fertilizer to be used in ratio are estimated using numbers. The planting of root and tree crops involves knowing the dimensions and spacing between each crop and the number of crops and required plots for proper propagation are mathematically calculated and depend on mathematical knowledge.
5. **Banking Sector:** The banking system plays the important role of promoting economic growth and development through the process of financial intermediation and is the conduit for the implementation of monetary policy. Banks play a central development role in every economy by mobilizing resources for productive investment. Transactions in banks occur with money but money is valued, counted and recorded using numbers. Bank transactions, including stocks, bonds and asset bases, are recorded using mathematics. Daily, monthly, and quarterly transactions are prepared with applications from profit and loss, percentages and higher arithmetic.
6. **Everyday life:** In everyday life, mathematics is central to the well being of our day-to-day activities. We use it in determining when we will wake up (time), how much we will spend throughout the day and how much our daily/weekly/monthly expenses will consume. We consider how many people are our dependents and use ratios to share money to them according to age, need, size or priority. At school/work, we check our work load and project a percentage of accomplishment that will give us a satisfactory pass mark. We consider weather reports that meteorologists have used mathematics to deduce to determine if we need to take umbrella or if it will be best to stay at home. We use computers that are founded on the principles of abacus and binary operation (0, 1) and mobile phones that are a result of mathematics via technology. At the end of the day, we assess the percentage of accomplishment for that day.
7. **Cryptography:** Cryptography is the study of hiding information for creating codes for, for example, Automated Teller Machines (ATMs) and debit and credit cards. ATM cards use numerical pins that give access to an account wherever it may be. Since the inception of ATM cards in Nigeria, banking transactions have been less stressful. With a simple four-number pin code, transactions ranging from daily banking, money transfers, and utility payments to mobile phone recharge cards can handled outside of banks. Cryptography is indispensable to safety in modern communications (Abubakar, Wokoma & Afebuame, 2011, pp. 54–63).

MATHEMATICS CURRICULUM IN NIGERIA

The mathematics curriculum currently in use in our schools has tended to concentrate too much on content. The issue of relevance and appropriateness, as derived from individual interest, ability and future vocation, is generally not addressed. Moreover, the curriculum in its present form is overloaded and is

rightly criticized for exclusiveness. Both the curriculum and the examination system offer only a school qualification which is hardly valued today by employers and society. The existing mathematics curriculum must be reviewed to enable mathematics students to acquire more knowledge of the application of mathematics to both societal need and self-reliance after graduation. The curriculum should be such that mathematics graduates do not end up only as teachers, but are able to render services to humanity and the community. Such services may involve the direct and indirect use of mathematics in solving problems (Eze, 2007). According to Eze (2007), the curriculum should expose mathematics students to at least one of computer programming, quantity surveying, design, actuarial science, accounting, or financial studies and planning. Osunde (1988) noted that the curriculum should prepare students for useful living which may be synonymous with the concept of self-reliance. A curriculum that prepares individuals for self-reliance or useful living must include some practical activities.

DEVELOPING AND RETRAINING MATHEMATICS TEACHERS

The National Educational Research Council (NERC) task force in mathematics (1977) in its report on problems among teachers stated that the quality of teacher preparation in our colleges is poor. Further, the status of teachers in our society is low and consequently the majority entering the profession does so because they have failed to obtain employment or training for more prestigious positions. To better meet the needs of mathematics education, teaching should be professionalized. Poor teaching methods have been identified as one of the factors causing poor performance among mathematics students in schools and discouraging them from pursuing mathematics in higher degree programmes (Eze, 2007). In addition to teaching challenges, there is a shortage of qualified tutors in both mathematics and methodology in Nigerian secondary schools.

These are among the reasons that the Mathematical Association of Nigeria (MAN) has begun to organize workshops for mathematics teachers in the primary, secondary and tertiary levels of education on how to teach the subject as well as on its presentation to students so as to enhance student performance. The National Mathematical Centre, Abuja, should continue to organize workshops aimed at retraining teachers in schools. This retraining and efforts to ensure that they have adequate teaching qualifications will aid in the production of mathematicians with better knowledge of mathematics and its applications. These mathematicians will, in turn, be better able to contribute meaningfully to the development of the economy and society (Eze, 2007).

TEACHING FACILITIES AND AIDS IN MATHEMATICS

There is an acute shortage of teaching facilities, textbooks, construction kits, pictures, graphs and charts for teaching mathematics in our schools. Teachers must depend on few textbooks, chalkboard, and chalk while students can depend only on the lesson notes given to them by teachers and the few textbooks. Ihebereme (2009) remarked that instructional aids needed for effective teaching are either lacking or grossly inadequate. In the midst of this inadequate provision of instructional aids, teachers seem to worsen the situation with a nonchalant attitude towards making improvised instructional materials. Ogwo (2004) posited that improvisation is the panacea for continued effective instruction and the realization of instructional objectives. Thus, to produce mathematicians for the 21st century, better facilities and reader-friendly textbooks should be made available to both teachers and students. The textbooks should expose students to the application of the topics covered and should be able to sustain the interest of the reader (Eze, 2007). Instructional materials including textbooks, construction kits, pictures, graphs and charts must be used extensively to make mathematics concepts real to students. The government, federal, state and local, should be ready to supply these required materials to schools (Okonta, 2009).

ADEQUATE FUNDING FOR MATHEMATICS EDUCATION

Funding problems are central to the effective teaching of mathematics in our schools. According to Okebukola (1995), inappropriate funding, poor teacher training/welfare, the shortage of instructional materials, a diminishing regard for the value of education, social decadence and political instability are

among the greatest barriers to the effective teaching of mathematics and science in Nigeria. Among developing countries, Nigeria has one of the lowest levels of expenditure on science, technology and mathematics research (Okafor, 2000). Inadequate funding affects the provision of facilities and the recruitment of the desired faculty to implement the curriculum. This, in turn, affects the level of quality obtainable. There are many schools that still do not have science equipment and facilities for the proper teaching and learning of science, technology and mathematics. The Science Teachers Association of Nigeria (STAN) in Iyobhebhe (2002) has observed that:

- Teaching-learning resources are grossly inadequate for communicating science, technology and mathematics (STM) in our schools; and
- The lack of adequate incentives for science teachers is a very serious barrier to effective STM teaching in Nigeria.

Adequate funding can also allow for the provision of bursaries and scholarships to students in mathematics education. This is likely to greatly improve teacher and student interest in this subject, thereby enhancing tertiary enrolment in this area. Mathematics teachers should be regularly encouraged to help them develop a greater commitment to their responsibilities.

EFFECTIVE PEDAGOGY IN MATHEMATICS EDUCATION

Pedagogical knowledge is specific knowledge about learning and teaching processes. This knowledge is vital in ensuring that content knowledge is transmitted to learners in ways that ensure that effective learning really takes place. Effective teaching involves three different types of knowledge. These are content knowledge, pedagogical knowledge and pedagogical-content knowledge. A teacher's content knowledge is his or her specialist subject matter knowledge. Pedagogical-content knowledge refers to the specialist teaching and learning knowledge that teachers develop while teaching their own specialist subject matter. Proficiency or expertise in teaching, recognized as important in promoting superior learning (Cornford & Athanason, in Iyobhebhe, 2002) can only be attained by mastering of these three types of learning. It is unlikely that Nigerian mathematics teachers have had enough time during their training to master these skills.

Mathematics education, being naturally activity-centred, would be an interesting area of study, were it not for the inappropriate teaching methods adopted by most teachers. These inappropriate methods such as lecture and exposition have scared away many prospective mathematics education students, even in primary and secondary schools. Teachers of mathematics education at all levels of education should therefore embrace the integrative approach to teaching. This approach, which should be both child and activity-centred, includes practical demonstrations, field trips, and the inquiry approach. All of these strategies are essential means for motivating learners to further study mathematics based courses in tertiary institutions.

MATHEMATICS: THE KEY TO NIGERIA VISION 20:2020

The present political dispensation has drawn up a roadmap to render Nigeria among the world's twenty largest economies by the year 2020. Mathematics is essential to the attainment of this vision. Pakes & Sokolof (1996) note that from the beginning, training in science, technology and mathematics is needed to produce scientists, technologists to create machines, and manned industrial processes that will convert vast natural resources into useful products. In fact, mathematics plays a pertinent social and economic role as a result of its widespread application in all areas of science, technology, industry and commerce. Having highlighted the immeasurable role of mathematics in ensuring the development of society, it is the view of the author that mathematics can be effectively used as a tool for achieving Nigeria's Vision 20:2020 agenda. This is more likely to occur if the recommendations listed below are implemented.

CONCLUSION

The value of mathematics in contemporary societies cannot be overemphasized. Mathematics has supported the realization of considerable technological developments and modern scientific breakthroughs. Ranging from the use of simple procedures to the application of complex solutions, mathematics today is applied in all aspects of practical science and technology. Most science education programmes, which make up the framework for technology, are replete with the use of mathematical methods. A building in a well-planned city, for example, first has to be designed, using math, after the land on which it is to be built has been properly surveyed, using math, and its topography understood and proper allowances made to ensure a durable structure, again using math.

In recognition of the role of mathematics and the need to improve the quality of teaching and learning of the subject, the Mathematics Association of Nigeria (MAN) initiated a mathematics improvement project intended to improve mathematics teaching in our schools. MAN better outlined how to teach the subject as well as how to present it to students in order to enhance their interest and performance. The Science Teachers Association of Nigeria (STAN) has also made efforts to diagnose the problems plaguing science, technology and mathematics in Nigeria over the past two decades. Although various workshops, projects and programmes have been initiated as a result of these efforts, the success of these programmes has been minimal due to poor (and ingrained) teaching methods, inadequate teacher qualifications, rote learning, and overcrowded classrooms all of which have a negative effect on student achievement in mathematics.

In addition, students are exposed to curriculum that is far more theoretical than practical. Most times students find themselves memorizing mathematics formulas for the purpose of passing mathematics examinations. Students find it difficult to conceptualize the topics being taught, let alone think about their application. Most mathematics teachers come with little or no training in the pedagogy of teaching. The result is that they (teachers) teach and students often find it difficult to understand. Students succumb to simply making notes and struggling to memorize formulas for examinations. Mathematics pedagogy needs a considerable boost in order to overcome the challenges of persistent poor performance. Lastly, there is an acute shortage of teaching materials in our schools. Textbooks, construction kits, pictures, graphs and charts for mathematics are in short supply.

Recommendations

1. The existing mathematics curriculum should be reviewed to enable mathematics students to acquire a better understanding of the application of mathematics relevant to societal need. Nigeria needs a mathematics curriculum that addresses the needs of its society.
2. There is a need for the massive development and retraining of mathematics teachers through workshops so as to produce mathematicians with better knowledge of mathematics and its application in the development of the economy, science, technology and society in general.
3. There is a need for the adequate provision of mathematics teaching aids and facilities.
4. Nigeria must work towards the massive development of mathematics education through adequate funding and the provision of better and reader friendly textbooks to teachers and students.
5. Nigeria must also improve interest in mathematics through more effective pedagogy. To this end, mathematics teachers must use constructivist pedagogy in mathematics teaching and learning.

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