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Mathematics Curriculum Reforms in Botswana: An Historical Perspective

Modise Mosothwane
Associate Professor, Department of Science and Environmental Education, University of Botswana, Botswana

Abstract:
The purpose of this paper is to identify and analyze curriculum reforms that have occurred in mathematics education in Botswana. Botswana, a former British Protectorate adopted British mathematics curriculum for over eighty one years. At the pre-independence period, mathematics curriculum offered in Botswana schools was predominantly arithmetic at the primary level of education, arithmetic, algebra, geometry and trigonometry at the junior and senior secondary levels of education. These mathematics curricula were called traditional mathematics. However, there were some senior secondary schools which offered calculus as part of their mathematics curriculum, but the calculus paper was optional.
When Britain introduced modern mathematics in its schools in 1960, Botswana remained offering traditional mathematics in its schools. However, at the post independent period, Botswana introduced modern mathematics in its schools, beginning with junior secondary schools in 1968, then primary schools in 1970 and senior secondary schools in 1971.
The reasons advanced for introducing modern mathematics in schools was that traditional mathematics emphasized computational skills while modern mathematics emphasized problem solving skills which are skills required for use in the 21st century. In 1981, it was found that modern mathematics was lacking computational skills and it was agreed that a mathematics curriculum which encompasses both traditional and modern mathematics concepts would be the appropriate curriculum for Botswana. Consequently, a mathematics curriculum relevant and meaningful to learners was introduced in Botswana. When all the changes or adoptions were done, the curricula were benchmarked against those of Britain, the argument being that Botswana mathematic curricula would be of high standard and would be internationally recognized. Today mathematics curricula comply with UNESCO's philosophy of 'Education For All but are of high quality. Teachers are now involved in the development of mathematics curriculum and this would help them implement it with maximum effort because they own it.
In conclusion, it is recommended that the participatory model of curriculum development be used when developing curricula to give all teachers an opportunity to make contributions which could lead to quality mathematics education for Botswana.

Keywords: *Mathematics curriculum; Traditional Mathematics, Modern Mathematics.*

1. Introduction to the Study

Botswana became a British Protectorate in 1885 (Townsend-Coles, 1985). It was then called Bechuanaland Protectorate. Botswana became independent in 1966 after 81 years of British rule. It was named Botswana. After independence, Botswana continued using British curricula because it thought that using British curricula would help it to be internationally recognized and its quality education would be maintained. However, immediately after independence, Botswana realized that British curricula were not all relevant to its situation; hence it introduced new curricula that were relevant and meaningful to Batswana.

Botswana specifically wanted to have human resources for its science related careers which will make it economically competitive; hence it introduced reforms in science and mathematics curricula. However, reforms in mathematics and science curricula started first in Britain in 1960 but were introduced in Botswana in 1968.

Botswana wanted to be economically competitive with other countries. However, the reforms in British mathematics curricula were a result of spaceship competition between the then Eastern and Western blocs. Consequently reforms in mathematics curricula were introduced world-wide. Drastic changes occurred during the cold war between the Eastern and the Western blocs in the 20th century. The then Eastern Bloc countries led by the Soviet Union did not want the Western countries to know what they were doing in science and technology; likewise, the Western countries too did not want the eastern bloc to know what they were also doing in science and technology (Martin, et al, 2005). There were fears that the bloc which advances in science and technology could develop sophisticated weaponry and could attack the other bloc using such weapons (Howson, et al, 1981). When changes were introduced by developed countries, developing countries too changed their mathematics curricula to keep pace with changes in developed countries and to ensure that their mathematics curricula were not obsolete and dated (Mosothwane, 1982).

Britain made drastic changes in its mathematics curricula in the 1960s (Howson, et al, 1981). At this time, Botswana was still a British protectorate and as a result, followed the British Education System (Mosothwane, 1982). At the time Botswana was a British Protectorate, changes in Botswana mathematics curricula were not introduced and old curricula such as Arithmetic were still being taught in Botswana primary schools in 1966. However, Botswana realized that it would remain behind in science and technology if it did not change its mathematics curriculum. Therefore curriculum reforms in mathematics were introduced in 1968 in junior secondary schools and in 1970 in primary schools (Mosothwane, 1982). According to Chiepe (1981), Botswana trained its technicians and other technically related careers in Britain as it would make sense to train them there. Since education officers in Botswana were also British, they were highly influential in Mathematics curriculum. Furthermore Britain also financed education in Botswana and one would expect education officers 'to make sure that mathematics in Botswana would be aligned to that of Britain. Chiepe (1981) was of the view that basing our education system on that of Britain was a big advantage because it would give Botswana mathematics curriculum an international status. Consequently, Botswana students could study anywhere in the world. Keitel & Kilpatrick (2005) assert that changes in mathematics curricula were the results of the recognition that mathematics is the queen and servants of all subjects, hence its place in the school curriculum is justified.

2. Reasons for the Reforms in Mathematics Curricula

Changes in mathematics Curricula occurred because of two main reasons. The reforms occurred on an unprecedented scale and were the most discussed and visible ones (Klein, 2003; Senk and Thompson, 2003 & Watson, 1976). Firstly they were sparked by the Russians in 1957 when they launched Sputnik into space. The launching of Sputnik caused panic amongst the Western world, especially the British and the Americans (Martin, et al, 2008). Having realized that they were behind the Russians in science and technology, the British and the Americans launched several mathematical projects (SMP, Nuffield, SMSG, and SSCIS) into their school curricula (Howson, Keitel and Kilpatrick, 1981). The aims of these mathematics projects were to boost students' mathematical skills and competencies and to ensure that students learnt mathematical concepts that would prepare them for a technological world. Changes were not only confined to the British and Americans. Changes in mathematics curricula also occurred in other countries, for example Germany and France.

Secondly, changes in the British mathematics curricula also affected its former territories (Mosothwane, 1982). Botswana, Lesotho and Swaziland being some of them, that implemented modern mathematics curriculum (popularly known as School mathematics Project (SMP) in their school curricula in 1968 (Chiepe, 1981). There was a general belief amongst Batswana educators that modern mathematics would lay a strong foundation for learning mathematics at higher levels of education. There was also fear that Botswana would remain behind in mathematics education and hence might teach obsolete and dated mathematics. Consequently, modern mathematics was introduced in both primary and secondary schools.

3. Curriculum Reforms in Botswana Primary Mathematics

Prior to 1970, mathematics in Botswana primary schools was mainly arithmetic (Menyatso, 2007) Arithmetic was considered essential for laying a foundation for learning mathematics at higher levels of education. According to Menyatso, computational skills were emphasized in Arithmetic, basically addition.

Menyatso's observation concurred with that of Schools Council: Mixed –ability teaching in mathematics that 'The only mathematical education for nearly all primary pupils was an intensive training in computations with money, weights and measures, and fractions. This was achieved with considerable repetition and was cumulative in that the simpler processes were component parts of the more advanced" (Schools Council Publications, 1977; p.19). Furthermore, Scopes (1973) reported that Mental Arithmetic was common in all Commonwealth Countries and its aim was to enhance children's computational skills. Menyato (2007) reported that Arithmetic Examination was comprised of three papers, namely Mental Arithmetic, (Paper I), Mechanical (Paper II) and Script (Paper III). Menyatso (2007) reported that mental arithmetic probed students' thought processes so that they could work fast with accuracy. In support of mental arithmetic paper, Schools Council Bulletin No: 1: Mathematics in Primary Schools also opines that it probed students' cognitive processes. Menyatso also reported that Script was an examination paper that was challenging to students because it tested problems solving skills. On the other hand, Menyatso contended that Mechanical paper gave students the opportunity to apply all computational skills learned in arithmetic.

In 1967, Chiepe (1981) was of the view that arithmetic was not helpful to pupils who wanted to study mathematics at higher levels of education. She wanted Botswana to have a mathematics curriculum in which students would be taught mathematical concepts that they could use after they had left school. Schools Council: Mixed –ability teaching in mathematics also made similar observations that agreed with Chiepe's:

> The aims and objectives of mathematics teaching have changed over time. This has happened in response to the changing needs of society and to a deepening understanding of what can be learned and retained so as to influence a pupil's capabilities after he has left school (Schools Council Publications, 1977; p.19).

Bergeron and Herscovics (1990) indicated that the problem with arithmetic was that it taught computational skills procedurally which required mere transmission of knowledge. This tended to be in conflict with the current views of mathematical learning. The current view on learning mathematics is that it should be learned conceptually, that is students should learn its language and learn how to use the language in a way that will promote understanding. Chiepe was of the view that Arithmetic was not teaching problems solving skills. This is what prompted reforms in mathematics curriculum.

Chiepe (1981) introduced modern mathematics in primary schools in 1970 (Mosothwane, 1982). Modern mathematics in primary schools was concerned with methods and radical reforms in mathematics content. Concepts such as sets, number bases, number series, mean, mode and median, angle construction and measurement were new to primary school teachers (Menyatso, 2007). Brissenden (1998) noted that when modern mathematics was introduced in primary schools, it created a debate on what method of teaching was better than the other. On the other hand Menyatso (2007) reported that in Botswana, the methods recommended for teaching modern mathematics were stated, but that the only problem that teachers encountered was the technical language used in teaching new concepts,(e.g. an element, a subset, etc). Menyatso reported that drilling students in steps of working out problems that involved computational skills was no longer being used. Instead of drilling students, practical activities were carried out. Although, practical work in Botswana primary mathematics was advocated for in 1970 in Britain it had been done for many years as indicated by Cockcroft. Cockcroft (1982) contends: 'The use of practical methods in the primary classroom is sometimes thought to be of relatively recent introduction but this is not the case; work of this kind has been advocated for very many years' (p.83). The essence of practical work was to develop positive children's dispositions towards mathematics. Furthermore, it makes learning mathematics enjoyable and meaningful. In Britain, it was noticed that drilling students in computational skills was no longer appropriate as noted by Servais and Varga (1971)

> Another remarkable characteristics in new mathematics teaching closely related to the cyclic course of learning, is total absence of drill in developing skills or in memorizing facts as an independent activity. Skills in formal arithmetic, for instance are not developed by doing sums mechanically, but by activities which lead to interesting new concepts and knowledge (p.24).

In Botswana, the justification for the introduction of modern mathematics at the primary level of education was that it would actively engage students and it would promote problem solving skills because it was based on the Chinese proverb: I hear and I forget, I see and I remember, I do and understand. Skemp (1978) and Math Education (2007), maintain that mathematical activities enhance understanding of mathematical concepts. For example when students study polyhedron, the best thing to do is to construct nets of different polyhedra because they would help children to learn concepts such as vertices, edges, faces, with understanding because they would learn the concepts practically. Skemp (1978) contended that in arithmetic children learn mathematics concepts instrumentally but in modern mathematics, they learn mathematics concepts relationally.

Although modern mathematics was introduced in Botswana primary schools in 1970, it was however, realized that some concepts were not helpful in the Botswana situation (Tiro, 2007). For example number bases were removed from mathematics curriculum because the mathematics panel realized they were not applicable to the Botswana situation. However, the panel realized that number bases were appropriate in countries where computers were used (Tiro, 2007). Primary school modern mathematics text books were written for the South African children (e.g. Standard 5 Mathematics textbook). This is because Botswana did not have teachers who were familiar with modern mathematics at that time who could write text books. This shows that Botswana was quick to introduce modern mathematics in primary schools when in-fact its teachers were not ready for the new curriculum. This had a negative impact on mathematics education in Botswana as its students performed poorly in mathematics because teachers were not trained in modern mathematics. The Botswana primary mathematics panel agreed to use South African text books because their environment was not at variance with that of Botswana. The panel agreed that Botswana should leave out number bases from mathematics textbooks when locally written mathematics books were available. In the mid 1980s, many Batswana mathematics teachers began to write mathematics textbooks relevant to their situation and consequently number bases and other non applicable concepts were removed from primary mathematics syllabus. The Department of Curriculum Development and Evaluation officers and Macmillan publishing officers prompted the writing of Botswana primary mathematics textbooks.

Botswana started having its own mathematics textbooks which were relevant to its context. The new primary mathematics curriculum coincided with the adoption of the United Nation's philosophy of Universal Primary Education (UPE). UPE called for free education for all primary school children. Botswana complied with the UN's recommendation of free primary education by introducing free primary education in 1981 and ensuring that each and every primary school going age child has access to education (Mantswe, 2007). Mantswe reported that the introduction of free education in Botswana in 1981 contributed to a substantial increase in the number of children who enrolled. He indicated that the number of children in classes also increased substantially. Consequently the attention and help teachers used to give to individual children were reduced. In his view, mathematics in primary schools was watered down, even though it was relevant and appropriate for Botswana. He noted that the performance of primary pupils went down.

In 1987, UNESCO made another recommendation that a basic education programme be introduced in all developing countries. Botswana was quick to respond to the recommendation and in 1988 Botswana introduced a Nine Year Basic Education Programme (Republic of Botswana, 1992 & 1993). The nine year basic education programme included junior secondary schools. It means that there were seven years of free primary education and two years of free junior secondary education. This move created a lot of problems such as shortage of classrooms in junior secondary schools, shortage of qualified junior secondary school mathematics teachers and other administrative problems (Ramaswami, 2007). As a result, the problems had a negative impact on the quality of junior secondary school education programme. Pupils who failed standard 7 examinations automatically transferred to junior secondary schools. This move caused a general disquiet amongst the public, parents, members of parliament, chiefs and industrialists argued that the introduction of Nine Year Basic Education lowered down the quality of education in Botswana.

In response to the complaints raised by junior secondary school mathematics teachers that primary children did not understand basic concepts taught in primary schools, the primary mathematics panel revised primary mathematics curriculum and included concepts such as solving equations and directed numbers in the primary mathematics curriculum (Republic of Botswana, 1992 &1993). The

argument raised for introducing these concepts at the primary level of education was that they would prepare students for learning mathematics at the junior secondary school level of education. Since the public was dissatisfied with the quality of the nine year basic education in Botswana, it was doubtful that introducing such mathematical concepts in primary schools would improve primary mathematics since the training of primary teachers did not include solving equations. Consequently, Government requested UNESCO to hold workshops for teachers in mathematics on basic education to showcase that indeed basic education programme embraces the concept of quality education (Republic of Botswana, 1992). The general public was still dissatisfied with the nine basic education programme even after the inclusion of algebraic equations in the primary mathematics curriculum (Republic of Botswana, 1993). Responding to the public's complaints, the then president of the Republic of Botswana, Sir Ketumile Masire, appointed a National Commission on education in 1992 to review the entire education system of Botswana. The Commission's Report was published in 1993 (Republic of Botswana, 1993).

The National Commission on Education (NCE) revolutionized the entire education system in Botswana by recommending that a Nine Year Basic Education Programme be replaced by a Ten Year Basic Education programme. The NCE (1993) however, recommended that the number of years of primary education schooling remains seven and the number of years for junior secondary school level of education be increased to three. The Revised National Policy on Education (RNPE) of 1994 was a result of the NCE of (1993)'s report. The recommendations made in the RNPE (1994) have been fully implemented (Republic of Botswana, 2000).

The current primary mathematics curriculum is based on the RNPE (1994) and this mathematics curriculum calls for mathematics for all and suggest that in teaching children mathematical concepts, teachers should first use children's prior knowledge of mathematical concepts before they begin teaching. This has been clearly articulated in mathematics curricula preambles. The current primary mathematics curriculum is based on the philosophy of group work and discussion. This is in line with Vygotsky's theory of cooperative learning which asserts that 'What children can do together today, they can do alone tomorrow' (Vygotsky, 1978). Changes in mathematics curricula were not only confined to primary mathematics, drastic reforms also occurred in junior secondary school mathematics curriculum.

4. Changes in the Junior Secondary School Mathematics Curriculum

Prior to the introduction of modern mathematics in Botswana secondary schools, Botswana followed traditional mathematics syllabus comprised of arithmetic, algebra, geometry and trigonometry (Ramaswami, 2007). According to Ramaswami, traditional mathematics concentrated on a narrow range of mathematical skills at the expense of problems solving skills. Although there were questions on geometry which asked students to prove some theorems, these were routinely done. This was because teachers were not familiar with problem solving skills. Both students and teachers had to memorize certain steps to arrive at the correct answer. The geometry paper was the most difficult one for students. This made the students not see mathematics as a lively, inspirational and enjoyable subject. Some researchers asserted that traditional mathematics had an overemphasis on verbal memory as opposed to experience and understanding (Skemp, 1978), hence the introduction of modern mathematics.

Radical changes occurred in the junior secondary school mathematics curriculum in 1968 when modern mathematics was introduced for the first time in Gaborone Secondary School by Mrs. Pauline Chiepe in her capacity as an education officer, mathematics education (Mosothwane, 1982). Changes occurred in both content and methods of instruction. Chiepe adopted School Mathematics Project (SMP) which was introduced in Britain in the late 1950s and early 1960s (Howson, Keitel a& Kilpatrick, 1981; Stanic & Kilpatrick, 2004).

According to Chiepe, Botswana adopted the SMP series in the hope that it would lay a strong foundation for learning mathematics in senior secondary schools and at higher levels of education. There seemed to be a problem with this perspective, since SMP was specifically designed for very able students (Scopes, 1973; Reys, et al 2005). Common sense tells us that modern mathematics would therefore lay strong foundation only for students of high ability. However, some researchers were skeptical about leaving out some traditional mathematical concepts, from modern mathematics syllabus, especially numeracy and computations (Servais and Varga, 1971).

They argued that no successful and durable reform may be conceived without a reasonable knowledge of both traditional and modern concepts in mathematics. Integration of what has been valuable and rejection of what has been worthless was undertaken. The fear was that computational skills would be lost if only concepts of modern mathematics were taught. A comprehensive study conducted by Hart in 1981 indicated that students who did modern mathematics had a decline in computational skills. However, the study did not compare students who did modern mathematics with those who did traditional mathematics.

Although modern mathematics was introduced in Botswana in 1968, it was in 1980 when Batswana mathematics educators also realized that the graduates of modern mathematics lacked computational skills (Mosothwane, 1982). This observation led to the introduction of a mathematics curriculum comprised of both traditional and modern mathematical concepts. Hence in 1981, a new mathematics curriculum was introduced in Botswana junior secondary schools (Ramaswami, 2009). The essence of introducing this mathematics curriculum was to produce a well rounded learner who would possess both modern and traditional mathematical concepts. This mathematics syllabus for junior secondary schools was developed in the hope that it would lay a strong foundation for learning mathematics at higher levels of education. The new curriculum was implemented successfully (Ramaswami, 2009). However, the curriculum was affected when the length of junior secondary school programme was changed from three years to two years in 1988, and consequently the academic contents of the curriculum were reduced accordingly.

The NCE of 1993 recommended that the three year junior secondary school programme be re-introduced (Republic of Botswana, 1993). The emergence of the Revised National Policy on Education of 1994 was a result of the recommendations made by the NCE of

1993 (Republic of Botswana, 1994). In response to the policy document, subject panels developed new curricula benchmarking them against the old ones. This is in agreement with the observation by Servais and Varga (1971). In Botswana, the new mathematics curriculum was developed for the three year junior secondary school program using ideas from both traditional and modern mathematics concepts. Reasons advanced for changing from a two year to a three year programme was that in a two year programme students were immature to be absorbed into the world of work and also had limited mathematical skills (Republic of Botswana, 1993).
With the advent of technological advancement (computers, calculators), the current junior secondary school mathematics has been revolutionalized to be in line with Education For All, Millennium Development Goals and Vision 2016. The Revised National Policy on Education of 1994 (Republic of Botswana, 1994) called for the junior secondary school mathematics to be vocationally oriented, to emphasize skills such as problem solving and to relate content to the world of work (Republic of Botswana, 1996) Furthermore, the current junior secondary mathematics curriculum embodies cognitive development model which stresses the use of thinking processes in solving mathematical problems which are complex thus enhancing problem solving skills.
It has been realized that Botswana junior secondary school mathematics curriculum encourages the philosophy of the interaction model. The interaction model suggests that learning occurs as a result of students' interaction with each other (Wong, 2002). Wong opines "numerous studies have proven that learning in groups is an effective process in enhancing students' problem and collaborative abilities" (p.2). Interaction gives students an opportunity to ask each other questions and as such those who understand some mathematical concepts would help those who do not. Botswana had implemented the recommendations of the Revised National Policy on Education of 1994 which called for mathematical activities in class. The Three Year Junior Secondary Mathematics curriculum concurred with the implementation of the recommendation of the RNPE (1994) that mathematics should be taught using methods that are activity –oriented. The junior secondary school mathematics curriculum contends 'the learning activities column suggest some of the activities which can be carried out in a mathematics lesson. The programme recognizes teaching and learning processes that stress the need for students' active participation, understanding of mathematical concepts learnt and development of intellectual independence' (Republic of Botswana, 1996; p.i)
The old Junior Certificate Mathematics Curricula that Botswana used did not state the rationales for teaching mathematics. However, the current Junior Certificate Mathematics Curriculum has stated the rationale for teaching mathematics and this is commensurate with Vision 2016 and Education for All. The rationale for the current mathematics curriculum dovetails well with the Millennium Development Goals and is as follows:

- The Mathematics Programme will equip students with basic knowledge, skills and attitudes that would help enhance their prospects of employment and capable of using mathematics in the solution of real life problems
- Mathematics plays a great role in our society as a result of its widespread application in every sphere of life, in areas of science, technology, economy, agriculture and other social activities
- Through learning mathematics, students can develop intellectual growth, capacity to think and reason, create and operate the world around them, and developing sensitivities and imaginations.
- The present predominant teaching strategies of exposition coupled with drill and practice episodes will not achieve objectives of mathematics (Republic of Botswana, 1996; p.i).

The new mathematics curriculum emphasizes that mathematics should be learned conceptually. On the other hand old mathematics curricula emphasize that students should memorize steps for proving theorems in geometry (Tiro, 2007). Changes also occurred in senior secondary school mathematics curricula.

5. Changes in the Senior Secondary School Mathematics Curriculum

Before Botswana got its independence from Britain in 1966, traditional mathematics curriculum, especially Syllabus A was used in its senior secondary schools. Syllabus A (traditional mathematics) was comprised of Arithmetic, Geometry, Trigonometry, Algebra and Calculus (Mosothwane, 1982). Students in Botswana senior secondary schools were to write four papers (Paper I: Arithmetic and trigonometry, Paper II: Algebra and Paper IIII: Geometry) however, the calculus paper (Paper IV) was not compulsory. The fact that the calculus paper was not compulsory gave mathematics teachers the opportunity to ignore it in their teaching.
During the time Syllabus A was used, the prescribed textbook was actually the syllabus. In Botswana, a textbook entitled 'Ordinary Level Mathematics' by Harwood Clark was used by all schools offering senior secondary school mathematics course. The book was used for a long time up to the time when modern mathematics was introduced in Botswana senior secondary schools in 1971 (Swartland, 2009).
The introduction of modern mathematics brought reforms in both content and teaching methods. Modern mathematics was introduced a decade after the launching of the Sputnik into space by the Russians in 1957. However, the Western Nations responded quickly to the launching of the spaceship. For example, in Britain many projects emerged after the launching of Sputnik. Some of those projects included the Nuffield Mathematics Project, The School Mathematic Project; Mathematics for the Majority to name but a few (Howson, et al, 1981).
The reforms that occurred in Britain had a direct influence on the Botswana mathematics curriculum. Under the wise leadership of Mrs. Pauline Chiepe, Botswana decided to adopt the School Mathematics Project (SMP) or Modern Mathematics. In Chiepe's views, modern mathematics catered for the three Bloom's taxonomies, namely cognitive, affective and psychomotor domains. The practical part of modern mathematics aimed at ensuring that students practice skills required for measurements and other computational skills which would promote an understanding of mathematical concepts. The aesthetic aspect of modern mathematics has been summarized by A. N. Whitehead's famous quotation 'Every child should experience the joy of discovery'.

Although Botswana introduced Syllabus C (SMP) in its schools, this created problems because its teachers did not undergo in-service training (Mosothwane 1982). Some concepts were totally new to the teachers yet they were expected to teach them. Concepts such as *set theory*, *probability, number bases*, *relations, and topology* were to be taught by teachers who were never exposed to them in their pre-service education (Swartland, 2009). Furthermore the problem was compounded by the fact that Botswana did not have a Secondary Education College of Education to train mathematics teachers but only Primary Teacher Training Colleges to train primary school teachers.

The 1971 Report of the Examination Council of Botswana, Lesotho and Swaziland indicated that the performance of students from Botswana in modern mathematics was very poor (Ramaswami, 2007). Consequently, the government of Botswana thought it would be wise to introduce a secondary college of education to train more secondary school mathematics teachers. However, the expectations of government were shattered down when the applicants to Francistown College of Education have not passed mathematics at Ordinary Level. Most of the applicants had passed one or two subjects. The first group of students enrolled at Francistown Teacher Training College in 1971. The cohort completed their Advanced Teacher Certificate (ATC) in 1973 (Mosothwane, 1982). However, in the cohort, there were no mathematics education students (Chiepe, 1981). Teachers who were awarded Advanced Teachers' Certificate taught both junior and senior secondary school students.

At the time Modern Mathematics was being taught in senior secondary schools, another reform was introduced in 1972, mathematics for the very able students called 'Additional Mathematics' was introduced in Gaborone Senior Secondary School. This was the greatest effort ever made by Mathematical Association of Botswana (MAB) in improving senior secondary school mathematics programme. It was introduced at the time when the University of Botswana, Lesotho and Swaziland were in great need of students with strong mathematics background. Additional mathematics contributed to the improvement of mathematics education in senior secondary schools.

However, the situation got better when the then University of Botswana, Lesotho and Swaziland, Botswana Campus admitted students in its Teacher's Certificate programme. In this programme, there were students who majored in Mathematics Education. Student teachers who did Teacher' Certificate were taught modern mathematics concepts in their content and mathematics education courses (Mosothwane, 1982). After the first UBLS cohort, the teaching of modern mathematics in Botswana improved as indicated by the results of Cambridge Mathematics Examination of 1978 (Ramaswami, 2007).

As time went by, the Mathematical Association of Botswana (MAB) and other mathematics educators realized that students who did Modern Mathematics (Syllabus C) lacked some computational skills. There was a general concern amongst industries that graduates of modern mathematics could not work out arithmetic problems. Consequently, another reform was introduced in mathematics in which concepts from both Traditional and Modern Mathematics were taught together as a single mathematics syllabus. A mathematics curriculum comprised of modern and traditional mathematics concepts was appropriate for Botswana. A mathematics syllabus comprised of modern and traditional concepts was introduced in Botswana in 1981 (Mosothwane, 1982). The syllabus was called Mathematics Syllabus D and contained arithmetic concepts which raised the computational skills of students.

Another reform in senior secondary school mathematics was introduced in 1980. The syllabus was called '*Certificate in Mathematics'* (Republic of Botswana, 1980). The purpose of the course was to consolidate some Junior Certificate Mathematics Course and to cover topics which were relevant to those who would not pursue a science based career. Certificate in Mathematics comprised of *arithmetic*, *statistics*, *geometry* and *trigonometry*. The course taught students real life mathematics such as 'commercial arithmetic for those who intended to work in banks. However, this course was discontinued from senior secondary school mathematics courses because it was labeled mathematics for the 'incapables'. However, in view of demands for clerical work, it was a very useful course (Republic of Botswana, 1980).

The first students who did syllabus D wrote their examination in 1982. The report of the examination board indicated that the performance of students in the 1982 mathematics examination (Syllabus D) was much higher compared to the previous performances in modern mathematics (Syllabus C) (Ramaswami, 2007). At the same time, the University of Botswana was producing mathematics teachers who had a strong mathematics content knowledge. Ever since syllabus D was introduced in senior secondary schools, Botswana began to see a large number of students passing mathematics at senior secondary school level (Republic of Botswana, 1994)

The report on the National Commission on Education of 1993 indicated that it was time for Botswana to have its own curricula to replace the British oriented ones. It was argued that the British oriented curricula were not relevant to the Botswana situation and as such could deter the progress of many Batswana children who aspire to study science at higher levels of education. As a result, reviews were conducted by all subject panels. The aims of the panels were to ensure that Botswana's Education System was of high quality and its mathematics curriculum was of high standard. Such a move contributed to Botswana's quality mathematics curriculum. In response to the recommendation of the National Commission on Education of 1993, the mathematics panel came up with Botswana Mathematics curriculum which was benchmarked against Cambridge mathematics Syllabus D.

Therefore, the current senior secondary school mathematics curriculum is equivalent to Cambridge IGCSE mathematics syllabus and prepares students for mathematics at the university and college levels. (Tiro, 2007). The curriculum places more emphasis on promoting students' intellectual development, recommends the use of child-centered teaching strategies and the application of mathematical concepts to everyday life activities (Republic of Botswana, 1996). The development of the current mathematics curriculum was based on a number of theoretical models.

6. Models of Curriculum Development in Mathematics

The development of mathematics curriculum in Botswana was based on a number of theoretical models, namely, the objectives based model, the cognitive developmental model and the constructivist theoretical approach. The models are still being used. The objectives based model is predominantly used when developing curricula because emphasis is on mastery of content, gives curriculum developers direction, focus and guidance on selection of appropriate content. On the other hand, the cognitive model is being used to place content at the appropriate developmental level of the child. The cognitive developmental approach gives curriculum developers an opportunity to place content at the appropriate level of thinking while the constructivist approach takes into consideration children's prior knowledge when teaching mathematics. During the post independence era, the constructivist approach took more stage as it was recognized that children come to school with some form of knowledge not as blank slates on which to inscribe knowledge. The constructivist approach supports the notion that knowledge is socially constructed and prior knowledge plays a significant role in learning.

An oversimplified model of curriculum development in mathematics is displayed below.

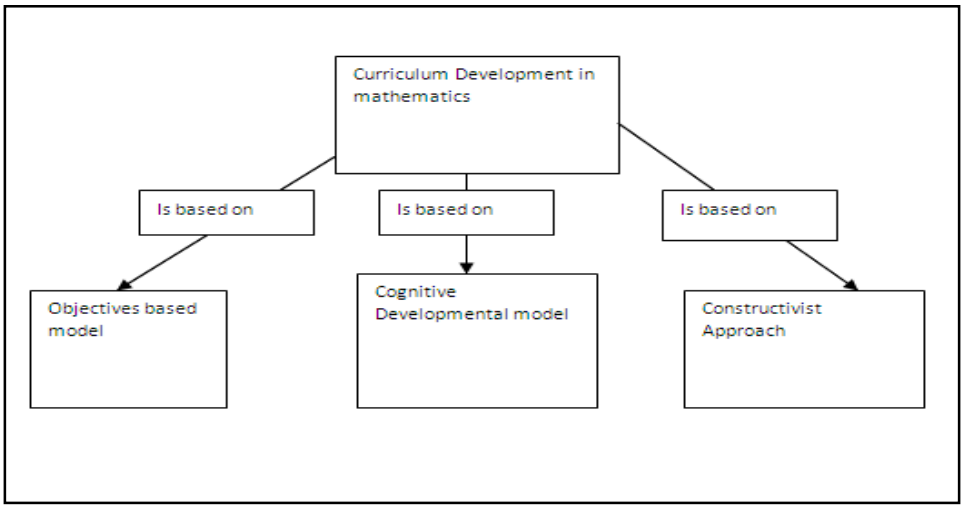

Figure 1

However, it has been realized that the models are not used linearly as suggested by the above diagram, the models somewhat interact and hence the use of the interaction model in developing Botswana's mathematics curricula.

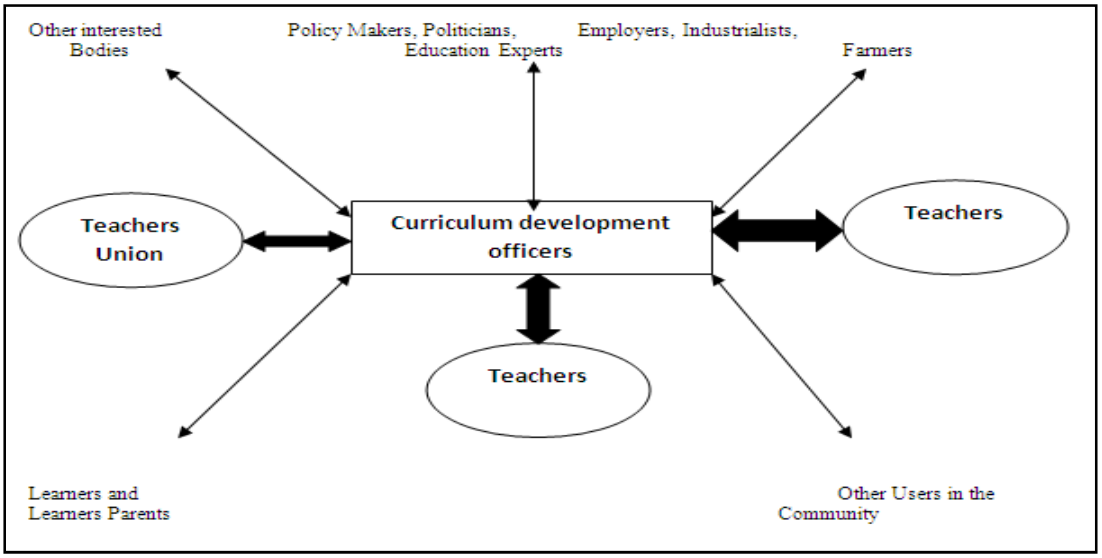

Figure 2: The Participatory Curriculum Development Model

In the context of Botswana, mathematics educators recognize that the participatory model of curriculum development could also be used to develop quality mathematics curricula because inputs of all stakeholders are taken into consideration and represent the views of society. The participatory model of curriculum development gives stakeholders ownership (Taylor, 1997).The essence of the participatory model of curriculum development is that it balances the local and global demands and ensures that interests of stakeholders are catered for and furthermore it utilizes learners' experiences (Taylor, 2003).

7. Conclusion

Curriculum reforms in mathematics occurred in primary, junior secondary and senior secondary schools. The aim of the reforms was to improve the quality of mathematics education in Botswana's schools. The reforms occurred at three historical levels, namely from Traditional to Modern Mathematics (Syllabus C) at all levels of education. During the time Modern mathematics was in use, it was realized that it did not contain more arithmetic problems that could enhance children's computational skills. However, it was realized that modern mathematics syllabus stressed practical work at the primary level of education supporting the view that mathematics can be taught practically. In modern mathematics, the dominant instructional strategy was discovery teaching.

The second historical reform was a change from modern mathematics to a mathematics curriculum consisting of traditional and modern mathematics concepts at the three levels of education. Changes were also introduced in instructional strategies, from discovery teaching to problem solving. At the third level of historical events, the new reforms emphasized knowledge construction and use of child-centered methods in teaching mathematics. The reforms were introduced at all three levels of education. Emphasis was on relating mathematics to real life situation, using examples that are in children's environment. The new primary, junior secondary and senior secondary school mathematics curricula call for conceptual learning rather than rote learning which was commonly stressed in the old mathematics syllabuses.

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