STAKEHOLDERS' RECEPTIVENESS TO AN ETHNOMATHEMATICS CURRICULUM FOUNDATION: THE CASE OF CAMEROON

by

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ABSTRACT

The purpose of this study is to assess the curriculum stakeholders' receptiveness to a curriculum built on an ethnomathematics foundation. The stakeholders who participated in this study were secondary school students, secondary mathematics teachers, pedagogic personnel and teacher educator. The students and the teachers were from two secondary schools in Cameroon, one of which was public and the other private.

Data collected for analysis include audiotaped interview transcripts, questionnaires and field notes from classroom observations of the teaching of an ethnomathematics unit. From an analysis and interpretation of the data, a picture emerged of the stakeholders' level of interests and concern about adopting an ethnomathematics curriculum foundation.

Findings from this study indicate that the stakeholders are generally receptive to an ethnomathematics curriculum but are also concerned about the demands such a curriculum would have on the cultural knowledge background of those in the mathematics classroom. The study also indicates that the stakeholders' encounter with an ethnomathematics approach can help them develop a broader view of mathematics and raise awareness of the presence of mathematical processes in cultural practices. The study notes that the stakeholders demonstrated both situational and actualized interests that were complex and not fixed. When a particular cultural activity facilitated mathematics teaching and learning, the stakeholders exhibited actualized interest to an ethnomathematics curriculum. When the lesson activities demanded much from the stakeholders in terms of cultural background knowledge and the teaching and learning implements, the stakeholders showed situational interest. The study also suggests that stakeholders' interests in an ethnomathematics curriculum are complex and interrelated, and are influenced more by external factors than by a given phenomenon.

The findings also suggest that stakeholders had some concerns regarding an ethnomathematics curriculum and that these concerns were more complex and varied with each stakeholder according to how each viewed her/his role in the education process.

The study's analysis of the stakeholders' receptiveness provides useful and important implications for relevant mathematics education, teacher education and above all, curriculum reform. It also highlights the importance of involving all those concerned with the education process to play major roles in the curriculum development process.

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Chapter 1

NATURE AND SIGNIFICANCE OF THE STUDY

1.1 Introduction

There is burgeoning literature (Bockaire, 1988; Carraher, Carraher & Schliemann, 1987; Gay & Cole, 1967; Gerdes, 1988 & 1994; Knijnik, 1997a, 1997b; Lakoff & Nuñez, 2000; Masingila, 1994 & 1995; Saxe, 1985, 1988 & 1991; Zaslavsky, 1973 & 1994) to demonstrate that the mathematics, which most people learn in contemporary schools, is not the only mathematics that exists. This demonstration of other forms of mathematizing has called into question commonly observed approaches to mathematical learning and teaching such as rote memorization, drill and practice, skills being taught out of context, a lack of connectedness within mathematics and responsiveness to the learner. In addition to the contributions drawn from the growing literature cited above, other research has also indicated considerations for enhancing the learning of mathematics to embrace the concept of cultural relevant teaching (Gilliland, 1995; Taylor & Stevens, 2002; Zaslavsky, 1994). This teaching perspective has been shown to be a promising aspect of education reform by seeking to promote academic success centred on students' cultural identities or cultural backgrounds.

These revelations and suggestions seem to have been embraced by the Cameroon government and a growing cadre of Cameroonian educators who have begun to promote a new vision of mathematics education similar to what many multicultural societies ascribe to. In 1995 the Cameroon government sponsored a one-week national forum on education involving Cameroonians of all walks of life with the aim of formulating a new educational policy for the country. This largest

gathering of Cameroonians since independence came at an unprecedented time in the nation's history of educational development and took place within a background of popular demands for democracy, decentralization, effective management, accountability, pedagogic reform and above all, relevance in education (MINEDUC, 1995). The last issue i.e. relevance in education was regarded as the most critical. Yet, government efforts at addressing this issue and many others have been slow and sporadic. Mathematics education is one of those areas that have received little attention. And while many educators in Cameroon believe that a relevant cultural perspective to the school curriculum may be the solution, there is little research work undertaken to understand how the curriculum stakeholders especially the teachers in the field will receive such a perspective. An ethnomathematics curriculum foundation may provide the relevant cultural perspective and knowledge of how the stakeholders will respond to such a curriculum and this is essential before such a proposal is submitted to the Cameroonian government for consideration.

1.2 Purpose of the Study

The purpose of this project is to examine the stakeholders' (students, teachers, pedagogic advisers/inspectors, and university faculty) interests and response towards a proposed ethnomathematics foundation to the school mathematics curriculum in Cameroon. In other words: **How receptive are the curriculum stakeholders in Cameroon to a proposed ethnomathematics foundation to the school mathematics curriculum?** To design a relevant and responsive school mathematics curriculum, it is important to understand the characteristics of the people who will engage in it; and to assess the people's interest, it must be done with respect to meaningful mathematical activities or objects, however broadly these activities or objects are defined. Furthermore, a thorough analysis of interest requires even more than a consideration of the person and the mathematics activity, because a person-activity interaction occurs within a social context, and the context can have a

considerable influence on that interaction, and thus on the person's interest. Thus, to assess the stakeholders' receptiveness to this proposed new vision, the study (1) developed a sample unit on a mathematics topic taught in secondary schools in Cameroon. This sample unit incorporated illustrations of mathematical concepts drawn from cultural practices in Cameroon. The sample unit was then tested with secondary mathematics teachers for its efficacy in the teaching and learning of mathematics; and (2) examined the response of the stakeholders towards the proposed alternative curriculum foundation by having them talk about their interests, concerns, potential problems and the possibility of implementing such a curriculum in Cameroonian secondary schools.

1.3 Rationale of the Study

It is generally agreed that mathematics knowledge is created and needed by all humans (Ascher, 1991; Bishop, 1988a, 1990; Burton, 1988; D'Ambrosio, 1985; Gerdes, 1997), but the process of imparting the formalized aspects of that knowledge i.e. *school* mathematics, has not yielded great results in many a society. Numerous studies have documented the poor level of students' performance and the declining enrolment numbers in mathematics and mathematics related fields of studies in high schools and universities in many countries around the world (see for example, Eshiwani, 1985; Hogbe-Nlend, 1985; Masingila et al., 1996). This situation is even more deplorable in developing or less developed regions of the world like Cameroon that are still struggling to emerge from the grip of their colonial past. Inappropriateness of the school curricula has been blamed for this situation, which has prompted the need for reforms, by the Cameroonian government. This is because school mathematics in Cameroon is continuously being taught as a set of rules and formulas that students have to memorize so as to be able to solve series of problems drawn out of life situations alien to the students. Yet, many reforms have been carried out over the last twenty years to remedy this situation with dismal

success (Ngwana, 2003). This is because most of the educational reforms, especially in the area of mathematics education, have for the most part focused on coating school mathematics problems with a thin veneer of 'real world' associations. The continuous failure of these reforms has also been attributed to the poor process of reform implementation (Ndongko & Tambo, 2000). This is because the major stake-holders usually affected by these reforms such as students and teachers are often not involved in the development and field-testing phase of these reforms. While it is encouraging to have an official policy statement on education stating that "the main aim of education in Cameroon is the reviving of the Cameroonian culture and the re-establishment of a Cameroonian personality" (MINEDUC, 1995, p. 2), what exactly those Cameroonian cultural elements are that should be incorporated into school curricula, and what sort of Cameroonian personality we expect to re-establish is not clear.

The transplantation of curricula from the highly industrialized capitalist nations to formerly colonized regions like Cameroon in the 1960s (e.g., the so-called 'African Mathematics Program') fanned the negation of indigenous Cameroonian mathematics. This has been cited as one of the fundamental causes for the verified low levels of attainments in mathematics (Fasheh, 1982; Bishop, 1990), students having to learn mathematics drawn from cultures completely alien to theirs. This project's focus is developed partly in response to the existing disconnection between school and indigenous mathematics, partly to the failure of past reforms, and partly in response to the ever-decreasing number of students enrolled in mathematics and mathematics related courses at the high schools and universities in Cameroon. The declining situation has necessitated the development of a curriculum that is more in line with the present realities in Cameroon by incorporating cherished cultural and indigenous knowledge practices familiar to Cameroonian children. While many educators in Cameroon (Eba, 1993; Nji, 1994; Ndongko & Nyamnjoy, 2000; Ngwana, 2003) believe that a cultural perspective to the school curricula may be just what is

required, there is little research work undertaken to understand how the curriculum stakeholders will receive such a perspective.

The foregoing discussion draws its impetus from three main issues: the problem of poor performance in mathematics education; the issue of cultural relevance in mathematics in terms of content, process and methodology; and finally the issue of educational (curriculum) reforms. These issues are discussed at length in the succeeding sections.

1.3.1 Performance in Mathematics

Mathematics in most developing countries such as Cameroon is continuously being taught as a set of rules and formulas that students have to memorize in order to apply these in solving textbook problems drawn out of life situations alien to the students'. Appropriateness has hardly been a guiding principle when developing a school mathematics curriculum. For most students and teachers in Cameroon, studying mathematics is basically to enable them to pass the many public examinations they engage in at various levels of education. After close to a quarter century since school mathematics was made compulsory to all junior secondary schools, the data on students performances has not been encouraging, to say the least. Reforms over the years have focused on identifying clear objectives for mathematics education without a contextual philosophy. Although the cited objectives of teaching mathematics usually assert knowing certain mathematical facts and being able "to think correctly, logically, and scientifically" (MINEDUC, 1995) this has not been the outcome. The reality is that Cameroonian children are failing to learn mathematics effectively in school.

Ekane (2000) has documented the degree of failure through the analysis of test scores and students' performances in mathematics certificate examinations. However, research findings based on testing procedures do not fully reveal the nature of the difficulties experienced by Cameroonian children when faced with the

task of learning "Western" mathematics in the school environment. Nor do such findings reveal the degree to which present approaches to mathematics education result in Cameroonian "children perceiving school mathematics more in terms of a meaningless ritual than as a purposeful pursuit" (Hogbe-Nlend, 1994, p. 13). The result is that after several years of schooling many children have only learned the answers to mental arithmetic that have little relationship with the world as they know it. Much of this unusable mathematical knowledge is soon forgotten, both between periods of school attendance, and once school days are left behind. If this situation is to be remedied, Cameroonian people and educators must together negotiate the *what, how* and *why* of mathematics education for Cameroonian children.

Unlike the other subject areas, there is a steady decline in the number of students taking up Advanced Level (A-Level) and higher level mathematics in universities in Cameroon. Ekane (2000) points out that the number of students who took up A-Level mathematics in 1998 was similar to what it was 10 years ago. However, since 1963, there has been a substantial increase in number of students participating in high school and university education. The number of students taking A-Level mathematics has been rising since then and seems to have reached its peak in the early 1990s. However, since 1992, the rate of students taking A-Level mathematics has been falling steadily by almost 15% (CGCE Board, 1998).

On the other hand, the National Research Council's (NRC) report *Everybody Counts* (NRC, 1989) asserted that "mathematics is the worst curricular villain in driving students to failure in school. When mathematics acts as a filter, it not only filters students out of careers, but frequently out of school itself" (p. 7). Beside this assertion, there is little hard evidence to support the claim that poor performance in mathematics is possibly one of the many factors that leads to the problem of low intake in mathematics and mathematics related programmes in high schools and other higher education institutions. Past literatures (Dick & Rallis, 1991) have shown

that when students choose a subject to specialize in at A-Level or university, they are very much influenced by the perceived relevance and usefulness of the subject areas in their future careers and their self confidence in that subject. If students perceived mathematics as a difficult, alien and irrelevant subject and they lack self-confidence in the subject, then they will avoid taking up this subject at higher level. Furthermore, Dick and Rallis (1991) found that the effect of socializers, including parents, teachers and peers in influencing both subject choice and career choices could be subtle but powerful. Thus, I wish to argue that if the teachers' and pedagogic specialists' understanding of the relationship between mathematics and culture is poor, then we can expect that these socializers or significant others in the lives of students are likely not to encourage the students from taking up mathematics, at higher level. Consequently this problem of low enrolment of mathematics students at higher level may be perpetuated.

Yet, there are still a number of issues that need to be addressed here. Firstly, before further effort is given to promote the incorporation of relevant cultural practices into school mathematics curricula (content, process and methodology), and to change the widespread views about the cultural neutrality of the content and process of mathematics, we need to have a better understanding of the stakeholders interest and response to this ethnomathematical approach. Unfortunately, reviews of related literature indicate that relatively few systematic research studies have been conducted on the stakeholders' receptiveness to this ethnomathematical approach. Most studies have dealt with demonstrating the possibility of applying such an approach in the teaching of mathematics. Other studies have focused on demonstrating the existence of this cultural knowledge and strategies with the hope that the revelation of the existence of this kind of knowledge will get those involved in curriculum reform and the process of teaching to incorporate these into their curricular prescriptions and teaching strategies.

In arguing that the students' poor performances and continuous decline in enrolment in mathematics and mathematics related fields of study and the failure of reforms in mathematics education is about responsiveness and relevance, I draw upon cultural and sociocultural theories of learning to aid my analysis of the level of stakeholders' receptiveness to an ethnomathematical foundation to the school mathematics curriculum. In this analysis, I asked: how receptive are the curriculum stakeholders to a proposed ethnomathematical foundation to the school mathematics curriculum and, consequently, what are their main concerns and what changes would such a curriculum necessitate? The treatment of the findings will provide foundational guidelines in the successful adoption and implementation of this curriculum. The study is thus premised on the understanding that change in mathematics education is an interconnected process that depends on political developments in a country and cannot be sustained without the active participation of all stakeholders concerned. It begins with an analysis of the context of reform. This is done because it provides a practical account of how "reform and developments in mathematics education cannot be separated from the context in which these take place" (Mwakapenda, 2002) and the knowledge and assumptions influencing the formulation of reforms.

1.3.2 Cultural Relevance

Among the many problems facing education in general, and mathematics education in particular in Cameroon today, the appropriateness and responsiveness of the curriculum content is perhaps the most critical (Samoff, Metzler, & Salie, 1993). The mathematics curricula in Cameroonian secondary schools are governed by structures like the University of London General Certificate of Education and the French Baccalaureate, which are culturally laden to a very high degree. The transplantation (Bishop, 1990) of this alien colonial curriculum was "part of a deliberate" (Bishop, 1990, p. 55) and long-standing strategy of acculturation and assimilation by

the colonial governments (French and British) – "intentional in their efforts to instruct in 'the best of the West', and convinced of their superiority to any indigenous mathematical systems and culture" (Bishop, 1990, p. 55). The adopted mathematics curricula ignored the fact that mathematical developments in other cultures, however different, followed different paths of intellectual inquiry, hold different concepts of truth, different sets of values, different visions of the self, of the other, of mankind, of nature and the planet, and of the cosmos. As a result, students are seldom taught that several of the ancient Greek mathematicians, Pythagoras and Thales for instance, travelled and studied in places such as Northern Africa where they acquired much of their mathematical knowledge (Joseph, 1991).

Cameroonian students know little of the mathematical inventions or applications of such ancient non-European cultures as the Egyptians, the Babylonians, the Mayan, etc. The students spend most of their time memorizing mathematical formulae and relationships of western cultures as would be demanded of them in the many national examinations they will be writing. The students are not aware of non-western contributions because the teachers themselves have not been taught that many cultures, including theirs, have contributed to the development of mathematics; cultures whose members were, and are, certainly intelligent, resourceful, and creative (Barta, 1995).

The implication of this is that many of the students are educated away from their culture and away from their society. Mathematics, a subject which, in fact, "could so easily have made connections with indigenous cultures and environment and which could have been relevant to the needs of the indigenous society" (Bishop, 1990, p. 56) is not thought of in those terms by proponents of a culturally neutral conception of mathematics, despite the current literature on the relationship between culture and mathematics. It is reasonable to suggest here that, as a consequence of the inappropriate curriculum content, large numbers of students fail their examinations in mathematics every year in Cameroon. For example, between 1994 and 1999,

the failure rate in the O-level mathematics examination has been running as high as 54% while the rate of attrition continues to grow (Ekane, 2000). This in turn is affecting the number of students who proceed to university to read mathematics or mathematics-related subjects like engineering.

Textbooks constitute the base of school knowledge, particularly in third world countries where there is a chronic shortage of qualified teachers. In many instances, teachers adhere closely to texts, using them as the sole source of school knowledge, assigning students lessons contained in the text and testing students only on the knowledge contained in the texts. "[Yet] most third world countries have been so immersed in the problems of providing schooling to children ... that they have paid little attention to curriculum development and even less to the content of school textbooks" (Altbach & Kelly, 1988, pp. 3, 10).

Two examples to contextualise Altbach and Kelly's (1988) argument for the case of mathematics textbooks content in the Cameroon education system are given below. In an introduction to the topic of 'probability' in one mathematics text being used, students are urged to note the following:

> Students (10-12 years old) should be able to list/display the possible outcomes when a die is tossed twice;
>
> Students should be able to answer a question such as 'Is it as easy to become a millionaire in Cameroon as in England or in Tanzania?' with explanations. (Berinyuy, 1998, p. 59)

The content of the above examples reveal much about the forms of mathematics being valued and ways of operating in mathematics practice. In the first example, why use the term 'die' which the students may not be familiar with? The question could be made culturally relevant by couching it in terms of cowries which are common and familiar to the students. In the second example, an assumption is

made that students are in possession of economic knowledge of England or Tanzania which may not be the case.

On the issue of making *real world* contexts accessible to students in a mathematics classroom, Silver et al. (1995) conclude that "increasing the relevance of school mathematics to the lives of children involves more than merely providing 'real-world' contexts for mathematics problems; real-world solutions for these problems must also be considered." (p. 41).

The idea of building on children's informal mathematical knowledge developed in part from the foregoing theory of how understanding develops, especially in mathematics. If we see children's informal mathematical knowledge as part of a well-connected network of ideas and concepts, then using that knowledge as a starting point from which to base instruction does not only make sense but is also relevant. Evidence confirms that helping all those involved in the process of mathematics education build on children's informal knowledge in mathematics classrooms helps children use their intellect well, make meaning out of mathematical situations, learn mathematics with understanding, and connect their informal knowledge to school mathematics (Carpenter et al., 1989; Fennema et al., 1996; Mack, 1990). This viewpoint is supported by Matthews (2003) who states that teaching from a student's cultural background is "more than merely presenting cultural information through 'cultured' examples and illustrations, it must be understood that the very act of building on students' cultural knowledge is essentially an active one, and a dialogical endeavour." (pp. 79-80)

One of the methods that certainly lends itself well to such an approach and to this project is that of ethnomathematics research. Since D'Ambrosio coined the term "ethnomathematics" over twenty years ago, this research field has been recognized as a valid educational tool in mathematics and mathematics education with already recorded levels of success in uncovering and understanding mathematical processes embedded in cultural practices and enhancing the teaching and learning of school

mathematics (See for example, Ascher & Ascher, 1981; Boaler, 1993; Gerdes, 1988; Masingila, 1994). Many mathematics educators and researchers alike are already employing this approach to mathematics education and research. For example, Gerdes (1988) has used an ethnomathematical approach to 'uncover' hidden moments of geometrical thinking in Angolan sand drawings; to develop a better understanding of mathematics practice in everyday situations, Masingila (1994) has used this approach to identify the mathematics concepts and processes used in the context of carpet laying. These brief examples of recorded successes (Gerdes, 1988; Masingila, 1994) in ethnomathematics research demonstrate the wealth of mathematics knowledge not being tapped into. As long as the view of mathematics as a culturally neutral subject continues to be promoted, students' performances in school mathematics will continue to be poor. Hence, school mathematics will continue to be meaningless, elitist, incomprehensible and unpopular to the vast majority of students not only in Cameroon, but the world over.

This study thus proposes that one of the ways Cameroonians can break away from this cycle of inappropriate education is by identifying individual characteristics, practices and behaviours that are valued in the society, analysing them, and according to priority, developing a curriculum that would develop such individuals. To do this, the Cameroon government needs to get all those involved in the education of the child to participate in crucial decision making sessions regarding the curriculum. The role of the teachers and students needs to be emphasized, and most importantly input from the students should be seriously considered since they are the ones who are going to be affected most.

1.3.3 Education Reforms

Reforms in mathematics education in Cameroon have not so far solved the inherent problems precisely because of their reformist nature. Reforms in the last two decades have merely rearranged the same content into a "new and improved"

format. To make education in mathematics more relevant, responsive and appropriate, new instructional methods and materials, and appropriate curriculum content must be sought, examined, and incorporated. Apart from claiming that school mathematics in Cameroon is "devoid of everyday life" (Nji, 1994, p. 9), very little or no attempt is being made to consider many instances in mathematics textbooks in Cameroon, in which the meaning and image of mathematics and connections between school mathematics and everyday reality are in fact inappropriate, distorted and inadequately addressed. Teachers, researchers, mathematicians, and policymakers have all argued about what curricula should be used in classrooms. Although opponents and proponents of different curricula have disagreed about the importance of contextualized mathematics instructions, they have rarely considered the ways in which foreign and transplanted curricula and mathematics content can or do impede students liking the learning of mathematics and claim of ownership in the development of mathematical knowledge. Yet, to be successful, the constant changes to school curricula call for different kinds of learning approaches and changes in the roles of each of the curriculum stakeholders i.e. students, teachers, pedagogic inspectors, university faculty and parents. I contend that the curriculum reform process could have been enhanced if it had considered what it means to provide an education that is shaped by an understanding of mathematics education as a process of migrating from acculturation to "enculturation" (Bishop, 1988a) together with an understanding that reform cannot be considered separately from contextual factors that influence its functioning in practice.

I will argue that success in any future reform policies will be determined by the degree of involvement of all the curriculum stakeholders. In line with Cameroon's aims of education in incorporating Cameroonian cultural elements, school mathematics seems a fertile ground for the incorporation of such cultural elements. This view is being supported by a growing number of mathematics

educators who see a culturally relevant approach as germane to success in mathematics education for all. But before we jump into implementing culturally relevant teaching approaches, it is important to understand how such approaches would be received by those who stand to be affected the most. This study thus aims to make a systematic enquiry into the receptiveness of the stakeholders (students, teachers, pedagogic inspector/adviser, university faculty) to a proposed ethnomathematical foundation to the school mathematics curriculum in Cameroon. Knowledge of the interests and response of the stakeholders will be germane to success of future curriculum reforms.

1.4 Significance of the Study

There is a growing call for appropriateness and relevance in school mathematics curriculum in Cameroon (Eba, 1993; Nji, 1994; NW-MTA, 2002), but very little systematic enquiry into how such a responsive curriculum would be received and implemented by the main curriculum stakeholders. Therefore the findings of this study will provide systematic and empirical data on the stakeholders' receptiveness to an ethnomathematical foundation to the school mathematics curriculum, which will be very useful in developing relevant curricula for other school subjects or knowledge domains.

Firstly, by working with those involved in the education process, the results of this study might inform us of the role each of the stakeholders play in effecting curriculum change.

Secondly, by demonstrating the presence of mathematics in cultural practices in Cameroon, this revelation might help develop in Cameroonian students, a greater awareness of the presence of mathematics in their everyday life. The findings might also promote in the students, the feeling and rightful claim of ownership to a vast amount of the mathematics knowledge taught in today's schools.

Lastly, the findings will suggest possible implications for mathematics education and mathematics teacher education. This knowledge may help to enhance better curriculum planning and teacher development programmes in the future. The findings might also encourage the local production of textbooks and educational resources that are more in line with the everyday realities of the learners and the teachers.

1.5 Conclusion

Research in educational reform must attend to the constituencies, their interests, and the dynamics among them, to understand how school curriculum reforms effect change or fail to. Efforts to reform school curricula must be examined in terms of underlying assumptions, social and historical contexts, and the values, ideologies, and goals of vested constituent groups. Having briefly described the current state of mathematics education in Cameroon, the importance and significance of cultural relevance in mathematics education, and the importance of involving all the stakeholders of the curriculum, I argue that there is a need to carry out this study.

Chapter 2 is a presentation of some theoretical perspectives on receptivity (with respect to the school curriculum) and some philosophical and theoretical foundations of ethnomathematics.

Chapter 3 is a presentation of a brief contextual chronological overview of the evolution of the school curriculum in Cameroon as a backdrop in developing the overall argument driving the project. This presentation is necessary because the evolution of the school curriculum in Cameroon is inextricably linked to its social and political history, and above all, to it history of colonial subjugation. This presentation is followed by a critical review of some related studies in the field of mathematics education research, with particular attention to research studies focus-

ing on the cultural connections to mathematics and mathematics teaching and learning.

Chapter 4 provides some background to the research setting, the research participants and the methodology employed in the collection of data for the study and an explanation of how the data was analysed.

Chapter 5 presents the findings related to the research question in the form of a comparative interpretive commentary.

Chapter 6 summarizes the findings in Chapter 5 in the form of an interpretive analysis, and indicates some considerations.

Chapter 7 summarizes the conclusions, recommendations and implications highlighted in Chapter 6. These conclusions, recommendations and implications are presented in the form of curriculum guidelines.

The appendices contain letters of information and requests for consent, research questionnaires and interview protocol as well as the ethnomathematics unit.

Chapter 2

THEORETICAL PERSPECTIVES

2.1 Introduction

This chapter begins with an operational definition of the term receptiveness based on the rationale outlined in Chapter One. Some conceptual components of receptiveness are explored to delineate it from other closely related concepts. Next, some philosophical and theoretical foundations of ethnomathematics are analysed in an attempt to develop a framework for the methodology and analysis used in this study.

2.2 Conceptual Components of Receptiveness

The term *receptiveness* is used in this study to refer to the level of willingness or readiness to favourably consider a new suggestion or proposal. A person's willingness to favourably consider an idea is often influenced by their level of interests in that idea. A person's readiness to consider an idea can sometimes be gleaned from his/her response to the introduction of that idea. Hence determining how receptive the stakeholders are to a proposed ethnomathematical curriculum foundation will require determining their level of interests and their response to the proposal. This is because interest is a powerful motivator for any action or change in behaviour, and as Deci (1992) asserts, "people typically pursue avocations primarily because of interest in the activities" (p. 43). However, he continues, "interest can also be an important motivator in one's vocation ... because people who are interested in their work are typically committed to doing it well" (pp. 43-44). Deci's assertions are in line with a view furthered by Piaget (1958) that each individual constructs new knowledge on the basis of actions which are of interest to the individual. Therefore

an understanding of the concept of interest in relation to receptiveness, especially with respect to curriculum change is germane.

The concept of interest has often been associated with intrinsically motivated behaviours because people seem to adopt those behaviours out of interest. Intrinsically motivated behaviours towards an activity are those done simply for personal reward of enjoying the activity itself i.e. they are usually freely undertaken. Deci (1992) argues that, "the quality of one's motivated behaviour differs as a function of the extent to which the person is interested in an activity" (p. 46). Even in self-determination theory, interest is also closely linked to intrinsic motivation by being "conceptualised as the core affect of the self – the affect that relates one's self to activities that provide the type of novelty, challenge, or aesthetic appeal that one desires at that time" (Deci, 1992, p. 45).

Extrinsically motivated behaviours towards an activity are those instrumental for some other reward, such as money, praise, or grades on a report card. That is, these are behaviours that are undertaken as a means to some end – as an instrument for achieving some outcome other than the spontaneous satisfaction that accompanies the activity.

When interest is defined as an affect that occurs in the interaction between a person and an activity (person-object interaction), one can then move to a focus either on the activity or on the person. For example, one can explore the characteristics of activities that tend, on average, to make them interesting to a group of people (e.g. curriculum stakeholders). By knowing what characteristics of tasks (e.g. ethnomathematics) are interesting to the stakeholders, it will be possible and easier to design educational materials (e.g. ethnomathematics curriculum) that, on average, will be more interesting and thus more intrinsically motivating for the stakeholders especially the students and teachers.

When interest is treated as a person variable by focusing on the degree to which a person is interested in a particular activity or class of activities e.g. ethno-

mathematics, then one is concerned with the person's enduring interests in an activity over an extended period of time. Such an approach allows interest to be viewed as an individual difference or "dispositional variable" (Deci, 1992, p. 46). Thus, the main nature of "interest" is that it is constantly changing in the web of the individual's personal culture, sometimes disappearing, at other times leading to new forms of interest. "Interests" then can be viewed as an intermediate by-product of the imagination processes that guide the person's mental/affective and actional systems towards some object.

Krapp, Hidi, and Renninger (1992) identify three related concepts of interest (1) interest as a characteristic of the person (individual interest), (2) interest as a characteristic of the learning environment (interestingness), and (3) interest as a psychological state. Both individual interest and interestingness can bring about experiences and psychological states in an individual that are generally referred to as interests. Typical characteristics of this state might include increased attention, greater concentration, pleasant feelings of applied effort, and increased willingness to learn.

Interests can pertain to objects in the physical or natural environment, to symbolic representations, or to activities (Rheinberg, 1989). Individual interests are conceived of as dispositions that are based on mental schemata associating the objects of interest with positive emotional experiences and the personal value system. Two forms of interest can be identified: *actualised* and *situational* (Krapp, Hidi, & Renninger, 1992, p. 6). Actualised interest is a state phenomenon while situational interest is generated by external stimuli. In other words, situational interest has more to do with the "interestingness" of the situation or object under consideration while actualised interest has to do with the intended actions as a result of the "interesting" situation. For example, when one says that a historical approach to the teaching of mathematics is an interesting approach but does not necessarily buy into the whole notion of using history in the teaching and learning of mathematics then

one is said to be expressing situational interest. On the other hand, if one says that a historical approach in the teaching and learning of mathematics is not only interesting but also essential, and one is quite willing to adopt this approach in their mathematics instructions, then one is demonstrating actualised interest. While the above illustration suggests that situational interest is often a precursor to actualised interest, a series of actions eliciting situational interest may lead to the development of dispositional interest which is different from actualised interest. In fact, Hidi (1990) argued that situational interest, triggered by environmental factors, may evoke or contribute to the development of long-lasting individual (dispositional) interests.

Efforts to measure interest usually lead to the operationalization of the concept on the basis of the person's encounters with specific external object domains of the world. The common-sense use of "interest" can be viewed as somehow linked with "motivation," which in turn is somehow linked to "effort," and "novelty." Valsiner (1992) views interest as an invented concept to refer to a certain psychological phenomenon. For example, if one says, "I am interested in a cultural approach to the teaching of mathematics" then one's actions and reasoning/feeling about a cultural approach to the teaching of mathematics all become parts of the phenomenon to be explained.

Educational research studies in the area of interest theory have tended to be on trying to understand the relationship between interest and academic outcomes. In such cases, interest is treated as a dispositional variable. With many of the studies correlational in nature, some of them, treating interest as a dispositional variable, have revealed a causal relation between academic interest and achievement in the school setting while others have found very little of a causal relation. But gauging one's interest in a process is a very difficult task especially if that interest has to do with one's profession. This is because interest when conceptualised as a person-object relation (Krapp, Hidi, & Renninger, 1992; Prenzel, 1988; Prenzel, Krapp, & H.

Schiefele, 1986; U. Schiefele, 1992, 1996) is characterized by value commitment and positive emotional valences. Interest-driven actions are characterized by experience of competence and personal control, the feeling of autonomy and self-determination, and a positive emotional state. These characteristics are often necessary for one to be receptive (express a favourable willingness to consider) new ideas or class of activities such as ethnomathematics.

Theories of instructions have suggested that classroom instruction and materials that are interesting play a large role in determining learning achievement (Hofer, 1986; Todt, 1985). This suggestion is based on an assumption that there is a relation between the interestingness of texts, its connectedness to the material covered, and the grades and later success of the student. Kubli (1987) conducted a study on the factors that contributed to the interestingness of physics, and concluded that girls could become more interested in physics if physics problems were linked to social or everyday situations. Similarly, Tobias (1990) came to the same conclusion with respect to students learning both mathematics and science.

The interestingness of an activity or class of activities does not usually explain why people respond positively or show a higher degree of interest in getting involved or participating. Deci (1992) contends that people's willingness to participate in uninteresting activities depends on their experiencing the activities as having personal importance or instrumental value to them. If people understand the importance of the activities, social contexts that are characterized by involvement and autonomy support will tend to foster the internalisation of regulations for these uninteresting though important activities. And through internalisation and integration, the activities may gradually become more interesting for the person. For example, students and teachers alike will be more motivated in exploring and understanding the production techniques of cultural objects such as fish traps in an attempt to glean the mathematics embedded in them even when the act of weaving fish traps is not an interesting activity. This motivation to understanding the

production techniques and consequently the mathematics embedded in the fish traps has a more personal meaning and importance to the students and teachers because they associate with the art of weaving fish traps and the rewards associated with producing a 'good' fish trap such as a cage full of fish.

Interest does not always occur when one is involved in a familiar activity, setting or object. Deci (1992) maintains that one can equally experience interest when one encounters novel, challenging, or aesthetically pleasing activities or objects in a context that allows satisfaction of the basic psychological needs and thus promotes development. When interest is experienced in this situation, it is often viewed as one's preferences or 'enduring interest'. While people tend to have stronger preferences for activities at which they are more competent or have greater potential, Deci (1992) also contends "regardless of people's level of proficiency, they are more interested in activities that provide optimal challenge" (p. 51). These preferences are influenced by the activities available in people's environment and by the social context, as people are more likely to develop preferences for optimal challenges that are available to them than for those that are not. Deci (1992) believes that this is because when people engage in activities within a social context that allows satisfaction of their fundamental psychological needs for competence, autonomy, and relatedness, they will be likely to maintain or develop enduring interests in those activities, whereas when they engage in activities within a social context that thwarts the satisfaction of the three psychological needs, they will lose or fail to develop enduring interests.

A study conducted by Köller, Baumert, and Schnabel (2001) to investigate the relationships between academic interest and achievement in mathematics among Grade 7, Grade 10 and Grade 12 students revealed that the relationship between academic interest and mathematics achievement is moderated by changes in the instructional setting and not wholly by the curriculum alone. They found that when instructions were not primarily driven by extrinsic values such as written examina-

tions and the associated positive and negative consequences, interest became a more important antecedent of mathematics achievement.

Students' interests in learning new content (e.g. ethnomathematics) can often be explained in experiential terms. For example, a student who is interested in ethnomathematics content means he or she is experiencing a certain quality of attention and a certain sense of delight. Deci (1992) concurs with this view by stating that "the experiential quality of interest has a positive hedonic valence and is related to the feelings of excitement and enjoyment..." (p. 49).

When a learner is able to identify a cultural connection with a learning situation, they tend to become interested in the learning activity. A study conducted by Pallascio et al. (2002) on Inuit students to identify the sociocultural elements that teachers and curriculum developers should consider along with students' interest and motivation when designing curricula and when planning instruction observed that the students manifested the weakest interest in the most decontextualized activities—that is, the activities having the fewest cultural connotations, whereas the more contextualized activities, which had greater cultural or everyday connotations, drew a more positive response.

Numerous studies have shown that competence-promoting information enhances interest (Deci, 1971; Harackiewicz, 1979; Ryan, 1982), whereas information that signifies or ensures incompetence diminishes interest (Deci & Cascio, 1972; Vallerand & Reid, 1984). Studies using path analytic procedures (Harackiewicz, Abrahams, & Wageman, 1987) have further confirmed that competence-promoting feedback and structure are important for enhancing people's sense of competence and in turn their intrinsic motivation and interest, whereas competence-diminishing feedback and structure undermine intrinsic motivation and interest.

The distinction between perceived self-competence and intrinsic motivation is also central to Deci and Ryan's (1985, 1991) cognitive evaluation theory. From this theoretical perspective, these authors posit that "we would expect a close relation-

ship between perceived competence and intrinsic motivation such that the more competent a person perceives him/herself to be at some activity, the more intrinsically motivated he or she will be at that activity" (1985, p. 58). For example, teachers are more willing to consider curricula changes if they feel that they are competent to implement such changes and they believe that implementing those changes will result in greater student learning.

The foregoing discussion on the concept of interest thus establishes a necessary aspect of the theoretical grounding of this study – the operationalization of receptiveness as a state phenomenon i.e. the degree of willingness to consider a new idea or class of activities – and how it will be used in both the data collection and analysis. The stakeholders' interests and response to an ethnomathematical foundation to the school mathematics curriculum will be examined by considering their expressed actualised (intended action as a result of working on an ethno-mathematics unit in the classroom) and situational (the interestingness of the ethnomathematics foundation proposal) interests during their participation in the study. Having outlining some conceptual aspects of the theoretical grounding of receptiveness guiding this study, I will now lay out in the ensuing section, some philosophical and theoretical perspectives on ethnomathematics. These perspectives are germane to the collection and analysis of the data in this study.

2.3 Philosophical and Theoretical Foundations of Ethnomathematics

One of the subjects of the ethnomathematical programme can be illustrated by the work of Gay and Cole (1967) in which they investigated the mathematics of the Kpelle society in the West African nation of Liberia. The purpose of their study was to find a way to build a bridge that would help the Kpelle use their mathematical experiences to learn the Western conceptualisations of mathematics. Gay and Cole did not expressly use the term 'ethnomathematics'; rather, they referred to this form of knowledge as 'indigenous mathematics'. The entrée of ethnomathematics

into mathematics education discourse can be traced back to two decades ago, specifically in 1984, when D'Ambrosio used the word at the Fifth International Congress on Mathematical Education (D'Ambrosio, 1984). Over the years, notions related to ethnomathematics have been frequently used by the literature and by popular writings on culture and mathematics. It is sometimes located within major fields comprising Cultural Anthropology, Anthropology and Archaeology, and Social Sciences.

From the root, *mathematics*, and the prefix, *ethno-* from ethnography, it can be presumed that ethnomathematics refers to the study of mathematics in relation to culture. However, despite its seeming popularity as a theoretical concept, it is still ill-defined. Although its importance as a research construct is well recognized by scholars, any reference to it in the academic literature is often fleeting and, at best, tangential. As a result, ethnomathematics does not permit rigid measurements and fine-grained analysis of its attributes. A respectable body of research literature on the topic is still being generated and only a handful of books on the subject are presently available. Providing an acceptable definition of ethnomathematics and some philosophical orientations are, therefore, the first steps toward a systematic study of the subject.

2.3.1 Some Current Definitions of Ethnomathematics

Before proposing a definition, it is worth examining the current definitions of ethnomathematics within anthropological literature. D'Ambrosio (1985) is perhaps considered as the forerunner when examining the evolution of the term ethno-mathematics and its varied definitions. Accredited for having coined the term ethnomathematics, D'Ambrosio defined ethnomathematics as the "mathematics practiced among identifiable cultural groups, such as national-tribal societies, labour groups, children of certain age bracket, professional classes, and so on. Its identity depends largely on focuses of interest, on motivation, and on certain codes and

jargons which do not belong to the realm of academic mathematics. We may even go further in this concept of ethnomathematics to include much of the mathematics which is currently practiced by engineers, mainly calculus, which does not respond to the concept of rigor and formalism developed in academic courses of calculus." (1985, pp. 45-46). This definition therefore suggests that "even the form of mathematics produced by professional mathematicians can be seen as a form of ethnomathematics" (Borba, 1990, p. 40). However, the definition is ethnocentric because it does not involve the standard study of mathematics (i.e. academic mathematics), implying that the term only suggests mathematics studied by other cultures.

Another definition is provided by Paulus Gerdes who is considered as one of the main contributors to the field of ethnomathematics. Most of Gerdes' work is on the elaboration of academic mathematics inspired by traditional practices. He defines ethnomathematics as "the cultural anthropology of mathematics and mathematical education" (Gerdes, 1997, p. 332). He views ethnomathematics as an active reclaiming of a mathematical point of view as part of indigenous culture. Gerdes' view concurs with D'Ambrosio's that ethnomathematics is a research field aimed at contributing to the mathematical awareness of colonised people and drawing attention to mathematics as a cultural product.

Ascher and Ascher (1986), two researchers of African counting cultures, defined ethnomathematics as "the study of mathematical ideas of non-literate peoples" (p. 125). This definition is too restrictive to permit a generalizable investigation of the topic. It implies that mathematics contains a cultural component only when discussing the mathematics of non-literate peoples (Borba, 1990). Further, it implies that a people can have a culture only if they are non-literate (or in some alternate way, an Other to the examiner of culture). This interpretation of ethnomathematics is a concrete example of ethnocentrism and an encouragement of the idea that proper mathematics is a notion defined only by the literate peoples. More importantly, with anthropology's acceptance of Boas' theory of cultural relativity in

the early 1900's, this definition also seems grossly antiquated. Boas (cited in Rosaldo, 1993) argued for the integrity of separate cultures which were equal with respect to their values. Differences between cultures with respect to technological or other development conferred them with neither moral superiority nor moral inferiority, including differences when compared to one's own culture (Rosaldo, 1993).

A somewhat concise definition of the concept is provided by Borba (1997) in his statements that ethnomathematics is the "mathematical knowledge expressed in the language code of a given sociocultural group" (p. 265). This definition clearly characterizes ethnomathematics as the study of mathematics which takes into consideration the culture in which mathematics arises. While this definition relates culture to mathematics and opens the door for testing hypothesized relationships between the two, it too seems inadequate to permit a more eclectic investigation of the topic. A broader definition of the concept that emphatically links its roots to the mores and values of groups of people is thus warranted.

2.3.2 Etymology and Operational Definition

An ideal starting point for defining a term is by borrowing its meaning from the dictionary. However, as mentioned earlier, the word ethnomathematics is not found in a standard dictionary. To the point, the definition of ethnomathematics has not been standardized at all. Nonetheless, few would disagree that etymologically ethnomathematics is the concatenation of the prefix *ethno-* onto the word *mathematics*. Thus, what is obvious is that there are two different literatures that examine ethnomathematics: Anthropology and Mathematics. From this, one can gather that ethnomathematics is at the crossroads of culture and mathematics. But, because these two subjects are so divergent, it is unclear exactly how they interrelate and give birth to ethnomathematics. A fitting definition can, however, be created by examining the word itself and the definition of the prefix *ethno-* and the root *mathematics*. The prefix ethno comes from the word *ethnology*. The *American Heritage*

College Dictionary (1993) defines ethnology as "the science that analyzes and compares human cultures; cultural anthropology." The same dictionary also defines mathematics as "the study of the measurement, properties, and relationships of quantities, using numbers and symbols."

Upon examination of these etymologies and upon examination of the conceptual differences in the mathematics of different cultures, it becomes apparent exactly how large a topic ethnomathematics is. Ethnomathematics does not only include the meekly interesting facts about how cultures count on their toes, fingers, or ears. It also includes a myriad of other topics that can be analysed and studied:

- What is the function of mathematics within a culture?
- How does mathematics affect one's culture (leading also to how technology affects ones culture)?
- Why is there a cultural feeling that mathematics is a universal subject?
- What conceptual differences are found in the mathematics of different cultures?
- How do different cultures count? Do these methods suggest something about the values of the underlying society?
- What mathematical area of study does a society stress, and what about the culture that dictated that those topics be studied?
- How do social hierarchies within a culture affect the development of mathematics within that culture?

To accommodate the myriad of topics above, the definition of ethnomathematics itself must not be a restrictive one. It must be simple and yet provide a basis to study divergent topics that emerge because of variations in human cultures. To accomplish this, it is important to look at some contemporary understandings of culture and mathematics.

Culture according to Hollins (1996), is:

> "the essence of who we are and how we exist in the world. It is derived from understandings acquired by people through experience and observation (at times speculation) about how to live together as a community, how to interact with the physical environment, and knowledge or beliefs about their relationships or positions within the universe." (p. 6)

While Hollins' definition focuses on what culture *is*, the meaning of culture can also be gleaned from definitions that look at what culture *does*. Hall (1977) quoted in Hollins (1996) concisely described the function of culture thus:

> Culture is man's medium; there is not one aspect of human life that is not touched and altered by culture. This means personality, how people express themselves (including shows of emotion), the way they think, how they move, how problems are solved, how their cities are planned and laid out, how transportation systems function and are organized, as well as how economic and government systems are put together and function. ..." (p. 5)

Discernible from the above definition is the suggestion that culture has a pervading influence on how a group of people lives and learns.

The following definitions of the term, culled from different sources, are equally relevant for the purpose of this study.

The *Oxford English Dictionary* (OED) defines culture as:

> **a**. "The training, development, and refinement of mind, tastes, and manners; the conditions of being thus trained and refined; the intellectual side of civilization. **b**. A particular form or type of intellectual development. Also, the civilization, customs, artistic achievements, etc., of a people, especially at a certain stage of its development or history" (The Oxford English Dictionary, 2nd Edition, 1991).

A *Cultural Anthropology* (Kottak, 1994) text defines culture as a concept distinctly pertaining to humans. "Cultures are traditions and customs, transmitted

through learning, that govern the beliefs and behaviour of the people exposed to them. Children learn these traditions by growing up in a particular society" (Kottak, 1994, p. 13). The concept of culture can be problematic since the word has numerous definitions and elaborations. "What most have in common, and what is significant for us, is that in any culture, the people share a language; a place; traditions; and ways of organizing, interpreting, conceptualising, and giving meaning to their physical and social worlds" (Ascher, 1991). Even within this definition, defining a group of people and their cultural aspects can also be problematic. "Because of the spread of a few dominant cultures, there is no culture that is completely self-contained or unmodified" (Ascher, 1991). Culture as used in this study refers to a set of norms, beliefs, values, and practices that are common to a group of people. Culture here is taken in its broadest sense. Thus one can talk of Cameroonian culture, working class culture, and also the culture of university mathematicians as a group i.e. it is not limited to race or place.

Mathematics refers to the study and use of numbers and symbols in relational terms. The focus is not only on the evolutionary aspect of its contents but also on how they are learned and used. The *Oxford English Dictionary* defines mathematics as follows:

> "Originally, the collective name for geometry, arithmetic, and certain physical science (as astronomy and optics) involving geometrical reasoning. In modern use applied, (a) in a strict sense, to the abstract science which investigates deductively the conclusions implicit in the elementary conceptions of spatial and numerical relations, and which includes as its main divisions geometry, arithmetic, and algebra; and (b) in a wider sense, so as to include those branches of physical or other research which consist in the application of this abstract science in concrete data. When the word is used in its wider sense, the abstract science is distinguished as pure mathematics, and its concrete applications (e.g. in astronomy, various branches of physics, the theory of probabilities) as applied or mixed mathematics" (The Oxford English Dictionary, 2nd Edition, 1991).

The emergence of the field of ethnomathematics is forcing a radical rethinking of our definition of mathematics. With the *uncovering, unfreezing* of mathematical practices hidden in many cultural practices (Gerdes, 1988), and the constant growth and development of the mathematics practiced by mathematicians (Tymoczko, 1986) around the world, there is the need for an ongoing adaptation of what mathematics *is*. For the purpose of this study, the nature of mathematics that will be used is one rooted in a falliblist philosophy that, according to Ernest (1985), "gives a realistic account of the nature of mathematics as it *is* actually practiced" (pp. 608-609) rather than as it *ought* to be. According to this view, mathematics is seen as a dialogue between people tackling mathematical problems. That is, mathematics is a human creation born of and nurtured from practical experience, always growing and changing, open to revision and challenge, and whose claims of truth depend on "guessing by speculation and criticism, by the logic of proofs and refutations..." (Lakatos, 1976, p. 5). Mathematical methods therefore are not perfect and cannot claim absolute truth. Mathematical truth is not absolute but relative because in fact truth is time dependent (Grabiner, 1986) and space dependent (Wilder, 1986). Time dependent because what is scientifically true today, might be a falsehood in the future as theoretical assumptions change, as occurred with the theories of Euclid and Ptolomeus. Mathematical methods are also space dependent because different peoples and different cultures have different ways of doing and validating their mathematical knowledge (Ascher, 1991). As such, it can be characterized as a human activity that cannot be viewed in isolation from its history, its sociology and its applications in life.

Although less able to offer a tidy overall philosophical picture of mathematics like other schools of thought on the subject such as: logicism, formalism, constructivism and Platonism, falliblism is perhaps the one school of thought on the nature of mathematics that offers to me, useful and interesting educational parallels and implications. For example, its denial of the externalised objectivity of mathe-

matics emphasizes individual experience, which in educational terms is a child-centred view. Falliblism, I will argue, is the only school of thought which sees history as germane to, and, beyond this, as an essential part of mathematics. From an educational point of view, a philosophy of mathematics which admits its history, sociology, applications in life and hence a consideration of the gradual evolution of mathematical concepts, is not only a valuable but also a commendable one.

Studies on contextualization have indicated the desirability of considering an individual's cultural environment. According to Bruner (1996), "all mental activity is culturally situated. Indeed, it is impossible to understand mental activity if one fails to account for the cultural environment and the resources it makes available – in other words, the myriad details which shape the mind and determine its scope. Learning, remembering, speaking, imagining – all of this becomes possible only because we participate in a culture" (p. 7).

A brief examination of the history of mathematics displays some of the relationships between culture and mathematics. Mathematical ideas and concepts as defined by Western culture, including arithmetic and geometry, were developed at various historical periods across the world, and different strains of mathematics were pursued in each culture. Different cultures stressed different aspects of mathematics and treated mathematics differently. For instance, many cultures classify mathematics differently and do not have a strong dividing line between Mathematics or Physical Sciences and the Social Sciences. In these cultures, mathematics is taught integrated within the humanities. Culture also greatly affects our view of mathematics; differential consideration of facts concerning the evolution of certain mathematical concepts and relations has distorted the history of mathematics itself.

Hersh discusses mathematics as a human activity:

> "Mathematics is human. It's part of and fits into human culture. Mathematical knowledge isn't infallible. Like science, mathematics can

> advance by making mistakes, correcting and recorrecting them.... There are different versions of proof or rigor, depending on time, place, and other things.... Mathematical objects are a distinct variety of social-historic objects. They're a special part of culture. Literature, religion, and banking are also special parts of culture. Each is radically different from the others. Music is an instructive example. It isn't a biological or physical entity. Yet it can't exist apart from some biological or physical realization—a tune in your head, a page of sheet music, a high C produced by a soprano, a recording, or a radio broadcast. Music exists by some biological or physical manifestation, but it makes sense only as a mental and cultural entity. What confusion would exist if philosophers could conceive only two possibilities for music—either a thought in the mind of an Ideal Musician, or a noise like the roar of a vacuum cleaner.... Mathematics is a social-historic reality.... There's no need to look for a hidden meaning or definition of mathematics beyond its social-historic-cultural meaning. Social-historic is all it needs to be.... forget immaterial, inhuman 'reality'." (Hersh, 1997, pp. 13-16)

When discussing the origin of mathematics, we cannot help but think about the usefulness of it and that it originated because of its use in society. Perhaps, however, it emerged because of its aesthetic quality and the enjoyment of creating order out of chaos through rational thinking. If you ask virtually any mathematician, he/she would agree to the statement, "mathematics, like music, is worth doing for its own sake" (Guillberg, 1997, p. 25). The usefulness of mathematics is what tends to conceal and disguise the cultural aspect of mathematics. Guillberg (1997) notes that no one ever asks about the usefulness of music: "The role of music suffers no such [cultural] distortion, for it is clearly an art whose exercise enriches composer, performer and audience; music does not need to be justified by its contribution to some other aspect of human existence". Mathematics, like music can exist without its usefulness, and can be appreciated as an exercise that enriches those who come into contact with it.

Different aspects of mathematics were developed at various historical periods by different cultures across the world. Proof that each culture developed its own mathematics is presented upon examination of the different methods developed for solving algebraic systems such as quadratic equations. Each culture stressed a different aspect of mathematics in its development. Babylonians invented a place value number system, knew different methods of solving quadratic equations (which would not be improved upon until the sixteenth century A.D.) and knew the relationship between the sides of a right-angles triangle, which came to be known as the "Pythagorean theorem (Joseph, 1997). Egypt pursued geometry to aid in the creation of complicated architectural structures. Egyptian fractions and the heightened accuracy of pi were developed as a tool for the development of these structures. India developed the number system and pursued more theoretical aspects of mathematics. We can examine the differences in mathematics from culture to culture and notice a culture's effect on the development of mathematics.

Greeks have been credited with the development of a more sophisticated form of mathematics that serves as the basis of what we use today. Despite the common perception that Greeks were the founding fathers of mathematics, Greeks learned most of their mathematics from Egyptians. Egyptian mathematics was superior to the Greeks, and the latter often went to be schooled in Egypt. Aristotle's teacher, Eudoxus, one of the notable mathematicians of the time, had studied in Egypt before teaching in Greece. Thales (d. 546 B.C.) was reported to have travelled widely in Egypt and Mesopotamia and learned much of his mathematics from these areas. "Some sources even credit Pythagoras (fl.500 B.C.) with having travelled as far as India in search of knowledge, which may explain some of the close parallels between Indian and Pythagorean philosophy and religion." (Joseph, 1997)

Documented evidence is found within even the Greek mathematical literature itself of the intellectual debt they owed to the Egyptians and Babylonians (a generic term that is often used to describe all inhabitants of ancient Mesopotamia),

and fulsome acknowledgement is given within many of the texts. There are scattered references of the knowledge acquired from Egyptians in fields such as astronomy, mathematics, and surveying, with sources varying from Herodotus (fl. 450 B.C.) to Proclus (fl. A.D. 400). Some Grecian commentators even considered the priests of Memphis to be the true founders of science. Aristotle (fl. 350 B.C.) considered Egypt to be the cradle of mathematics.

The Greeks are usually given credit for the determination of pi despite Egypt's more accurate estimate of pi. This is not surprising as the advancements of Africa are often attributed to others due to cultural misconceptions. To explain Egypt's responsibility for the development of pi, we must first examine their representation of fractions. Egyptians used a different representation of fractions in place of the common Western fraction format (which they had no knowledge of). The Egyptian representation of fractions remained the common technique of fraction representation and computation until the 19th century. The Egyptians represented a fraction by a sum of unit fractions, e.g. $1/a + 1/b + 1/c + \ldots$ where a b c are increasing integers. For example, according to the Egyptians, the fraction 5/6 can be represented by as $1/2 + 1/3$. In fact, every rational number can take on the Egyptian representation of fraction format. A famous "mysterious, so called, meaningless" triple, 13, 17, 160, was found throughout Egyptian architecture and manuscripts. When translated into Egyptian form of fractions representation, we notice that $3 + 1/13 + 1/17 + 1/160$ approximates pi to 4 significant digits which is much better than 3.16 which is usually attributed to the Egyptians.

We must keep in mind that mathematics is a cultural product. Other cultures, although they do have the ideas or concepts that we deem as mathematical, do not distinguish them and class them together as we do (Ascher, 1991). The definitions of mathematics are based solely on the Western experience, even though they are often phrased universally. Even within the Western culture, the definition of mathematics is fluid, and is generally defined to include whatever the Western professional class

called mathematicians do. An example of the fluidity of the definition of mathematics is cited by Barton (1996) concerning the traditional Königsberg bridge problem that was considered a recreational problem for centuries before becoming legitimate branch of mathematics as network theory. In the ensuing sections, I describe how mathematics developed and the role of culture in its evolution to set the stage for understanding ethnomathematics.

"Not much study has been done in ethnomathematics, perhaps because people believe in the universality of mathematics. This seems to be harder to sustain, for recent research, mainly carried on by anthropologists, shows evidences of practices which are typically mathematical, such as counting, ordering, sorting, measuring and weighing, done in radically different ways than those which are commonly taught in the school system" (D'Ambrosio, 1997).

There is a societal belief that mathematics is a universal and standard concept across ethnological boundaries. Barton (1996) characterizes this belief as borne of a philosophical difficulty and states that "there is little agreement on the extent to which mathematics is universal, and on how mathematical ideas can transcend cultures" (Barton, 1996, p. 201). Its theorems and laws are viewed as generalizable and universally applicable. This belief stems from mathematics' axiomatic principle that its premises and assumptions must be held as constant despite the variations in the usage environment. This constancy principle has endowed mathematics with an ideal platform, sought by less precise disciplines, to explain varying phenomena in comparative terms. There is a perception that mathematics is an effective tool for analysing, examining, and verifying truth. It has provided mathematics with an aura of objectivity amidst a predominantly subjective, chaotic, and nebulous world.

While its assumptions and theorems are universal, their application, usage, and even the methods used to learn them seem to be culturally influenced. Thus, just as a language (e.g., English) is spoken or written differently by people of different cultures, mathematics-related communication appears to be punctuated by cultural

differences and similarities. Some obvious examples are the following: Many mathematics languages are base-20, based on the number of fingers and toes. Nahuatl, a language of Central Mexico, is one of these, as is Chol, a Mayan language spoken in northern Chiapas, Mexico. The French language also expresses its numbers in a base-20 format after the number sixty. A number system of base ten may seem to be obvious to the reader because it matches the number of fingers on the hand. However, the Yuki of California think their system based on eight is the most logical for a similar reason. The Yuki's base eight system is based on the number of interfinger spaces. Knuckles are used in yet other cultures. Many cultures use different words for the same number depending on what they are counting. For instance, the Dioi language has fifty-five numeral classifiers. Gilbertese, spoken on the Gilbert Islands, which is now part of the Republic of Kiribati, has 18 numerical classifiers. Some of these are animate objects and ghosts, groups of humans, days, years, generations, coconut thatch, rows of thatch, rows of things (other than thatch), customs, modes of transportation, etc (Ascher, 1991). One study showed how diversely number counting can be done on fingers (Zaslavsky, 1991, 1994). Ten children were asked to count to eight on their fingers secretly. Then all at one, they were asked to display how they represented the number eight on their fingers. The children had a multitude of different ways of representing the number eight. It is thus clear that despite its universality paradigm, aspects of mathematics have significant cultural overtones. By examining these cultural attributes, factors contributing to teaching and learning-effectiveness in mathematics can be analysed and understood.

For the purposes of this study, therefore, arguments by Powell and Frankenstein (1997a) provide a starting point for a refined and concise definition on ethnomathematics as including

> "the mathematical ideas of peoples manifested in written or non-written, oral or non-oral forms, many of which have been either

> ignored or otherwise distorted by conventional histories of mathematics" (p. 9).

The above definition makes clear the subject of ethnomathematics. However, settling on a particular definition is a little futile because of the existing levels of contradictions within the ethnomathematics literature which according to Barton (1996), are "about the meaning of the term 'ethnomathematics' in particular, and also about its relationship to mathematics as an international discipline" (p. 201). Hence, rather than provide another definition of ethnomathematics, I have elected to offer statements about what ethnomathematics involves.

For this study, ethnomathematics will be seen both as a subject and process of the social construction of knowledge at a cultural level i.e.:

> the study of the culturally-related aspects of mathematics; it deals with the comparative study of mathematics of different human cultures, especially in regard to how mathematics has shaped, and in turn been shaped by, the values and beliefs of groups of people.

The above definition describes ethnomathematics as a legitimate offspring of the interaction between culture and mathematics. It suggests that the study and use of mathematics has cultural overtones and must be viewed as such. It offers a framework to discuss and explain evolutionary issues in mathematics as due to differences in human subcultures. At the same time, it suggests that the economic and technological disparities of societies can be explained by the influence mathematics has had on the thinking and behaviour of people of those societies.

Figure 2.1 diagrammatically provides a framework and describes the relationships of variables specified in the above definition. Relationships emphasize reciprocity between culture and mathematics. Culture affects mathematics, as does mathematics affect culture. The interplay within culture and mathematics is ethnomathematics.

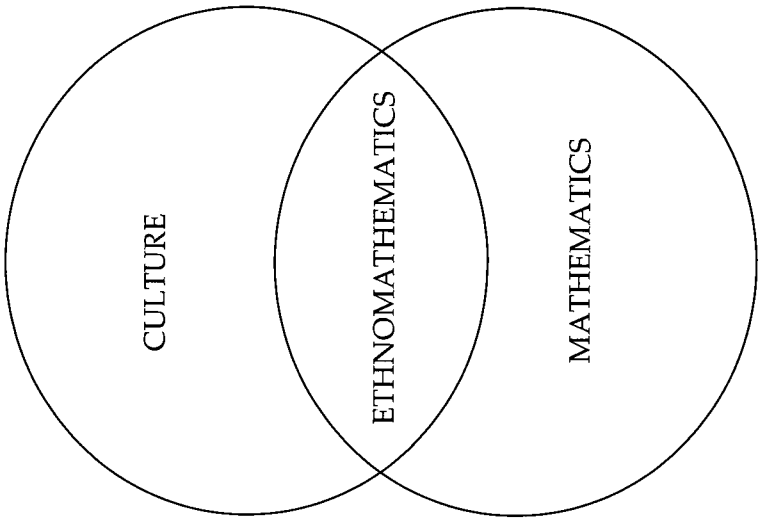

Fig. 2.1: Ethnomathematics: interaction between culture and mathematics

Ethnomathematical research according to D'Ambrosio is mathematics education research aimed at "analyzing the way in which mathematical knowledge is colonized and how this knowledge rationalizes social divisions within society and between societies" (1990, 1994). In trying to make sense of ethnomathematics, Barton (1996) identifies three dimensions on which ethnomathematical studies can be classified. These are time, culture and mathematics and each lies on a continuum with ethnomathematics studies located at any point in the space. According to Barton's classification, studies that focus on understanding the mathematical practices and conceptions of ancient societies are attending to the time dimension; studies that focus on analysing cultural practices for the presence of mathematics are adhering to the culture dimension; and studies that focus on demonstrating the presence of mathematics in every culture and advocating for unbiased historical accreditation.

Hence, ethnomathematics research will be characterized as "the cultural anthropology of mathematics and mathematical education" (Gerdes, 1997, p. 343) i.e.

a cultural window for examining any form of knowledge or social activity characteristic of a social and/or cultural group, that can be recognized by other groups such as anthropologists, but not necessarily by the group of origin, as mathematical knowledge or mathematical activity.

2.4 Conclusion

The foregoing supports the proposition that culture has occupied a central role in the development of mathematics. While economic nature seems to have given birth to mathematics, environmental factors unique to different societies have impacted its growth. Different societies in different time and space have influenced and, in turn been influenced by, mathematics' evolution. Understandably, while its theoretical components may be the same across societies, its application and usage are culturally biased.

In this section, I have examined the concepts of receptiveness and its conceptual components and delineated it from other closely related concepts. I have also explored the philosophical and theoretical perspectives of ethnomathematics in order to set the stage for a review of research studies viewed as ethnomathematical. I have offered statements describing ethnomathematics which illustrate the approaches I will use throughout this work. In the ensuing chapter, I will review some related literature in the area of the evolution of formal education in Cameroon, mathematics education and ethnomathematics.

Chapter 3

REVIEW OF RELATED LITERATURE

3.1 Introduction

This chapter begins with a historical overview of the evolution of formal education in Cameroon. This is followed by a brief review of studies on mathematics education from a social and cultural perspective. Finally, there is also a review of current literature on ethnomathematics studies.

3.2 Evolution of Formal Education

Almost all literate societies ascribe to a central consensual orthodoxy that education, particularly formal schooling is the requisite and the basis for any type of progress including economic development, social mobility, cultural preservation and transmission, and military sophistication (Seidman & Anang, 1992; Tambo, 1992; Azevedo, 1989). This consensus on progress through education concurs with a declaration at the World Conference on Education for All sponsored by UNDP, UNESCO, UNICEF and the World Bank, that

> "(E)ducation is a fundamental right for all people, women and men, of all ages throughout our world ... an indispensable key to, though not a sufficient condition for, personal and social improvement .... (A) sound basic education is fundamental to - self-reliant development...." (Seidman & Anang, 1992, p. 103)

If we are to recognize that schools exist in contemporary societies as agencies for the handing on of the common cultural heritage of a society (Lawton, 1973, 1980), and how each society is connected to the rest of the world, so that at least in part

their purposes must be seen in terms of socialization or acculturation, then the kind of education being referred to is just as important as the above declaration itself. The kind of education in question immediately conjures questions of the curriculum and its content. Curriculum according to Lawton (1980) is "essentially a selection from the culture of a society" (p. vii). Lawton's (1980) notion of curriculum as a selection from the culture implies that curriculum has the function of promoting the acquisition and mastery of the core values of the society for which it is structured (Omulando & Shiundu, 1992).

Lawton's (1980) point of view resonates with that of Julius Nyerere, former president of Tanzania, when he stated that the purpose of education is

> "to transmit from one generation to the next the accumulated wisdom and knowledge of the society, and to prepare the young people for their future membership of the society and their active participation in its maintenance or development". (Nyerere, cited in Bishop, 1985, p. 55)

The cultural heritage, the knowledge and wisdom accumulated by any society over the years, provides an important source for decisions such as what is to be included in the curriculum. Thus, curriculum, as an instrument of society for educating the young, naturally reflects the ideals and values, the knowledge and skills, the attitudes deemed significant by that society which will consequently develop a strong cultural identity and is transmitted through the process of enculturation (Bishop, 1988b).

This basic belief on the use of local cultural resources in the curriculum has long been upheld by Cameroon whose government has remained committed to providing the most basic educational opportunities to its people. The history of its school curriculum is inextricably linked to its political and social history. The Cameroonization of the University of London General Certificate of Education (G.C.E.) examination by the Cameroon Ministry of National Education since 1961,

was motivated by the ardent need the Cameroon government felt to have an examination based on a system that reflects to a great extent, the socio-cultural and economic nature of Cameroon, and yet ensuring the same rigour and scope in an education and examination system geared towards maintaining a world outlook and standards (Ndongko & Nyamnjoh, 2000). This arrangement with the British Department of Examinations, the British Senate House, the University of London, the British Government and the then Federal Republic of Cameroon was therefore an assurance to some Cameroonians who viewed the British-run educational system as a source of acculturation at best, or cultural alienation at worst, to return into the fold at the time of unification[1] and support the school in an attempt to foster national unity (Ndongko & Nyamnjoh, 2000). There is no doubt that, in Cameroon, dramatic progress has been achieved in this respect since the advent of the Cameroon General Certificate of Education examinations in 1977.

However, what this agreement between the British Government and the then Federal Republic of Cameroon did not envisage at this point was identify the philosophical and ideological dimensions of the cultures of Cameroonian peoples and interpret the same for curriculum development and implementation. Rather, they focused primarily on the expressive aspects of the traditional cultures such as songs, dances, art works which were treated as an after school activity (DeLancey, 1989). Most of these aspects were not even tested in a Cameroon educational system that was rooted in national examinations. Some school subjects were not even seen as emphasizing non-Cameroonian cultural value systems. Such was the case with school subjects like mathematics, physics, chemistry, and biology, to name but a few. The case of mathematics was strongly contested based on arguments that mathematics, especially school mathematics was culture-free. The strengths of such

[1] In 1961 the British-ruled Southern Cameroons in a plebiscite organized by the United Nations, voted to re-unite with their French-colonised East Cameroon to form a Federal Republic of Cameroon.

arguments have waned thanks to ongoing discourse on culture and mathematics. Hence, what I think is required at this point is a deep understanding of the philosophical and ideological dimensions of the cultures of Cameroonian peoples and viewing those philosophies and ideologies to be significant to the process of development and implementation of curriculum for cultural identity in not only mathematics and the sciences but the arts as well.

The focus of this section is twofold. The first part will be a chronological analysis of the historical evolution of the curriculum in Cameroon from the pre-colonial, the colonial and then to the post-colonial era. This analysis is necessary for two reasons: (1) it provides an understanding of the school curriculum as a continuously negotiated terrain by highlighting the conflicts, compromises, and processes of negotiations, through time, of the present curriculum in Cameroon; and (2) it places into context the significance and the rationale for this study as outlined in Chapter 1, and makes the case for a much needed culturally relevant curriculum for Cameroonian schools. It will be argued that the school curriculum in Cameroon hasn't changed by much since the dawn of independence, notwithstanding considerable expansion in educational facilities (DeLancey, 1989; Tambo, 2000) and an increase in the proportion of school-age children in school in the country. In charting the evolution of the curriculum in Cameroon, I will discuss the plethora of efforts aimed at harmonizing the two systems of education (French and British), in an attempt to create a kind of national curriculum.

3.2.1 Pre-colonial Education and the Birth of Formal Education

This section introduces pre-colonial education in Cameroon and lays the foundations for the analysis of the evolution of the school curriculum to follow in the next section. Prior to European arrival, the Cameroonians identified themselves as members of a particular ethnic group. Most of the power among the ethnic groups was vested in the traditional rulers (chiefs or kings)(Ardener, 1996). The ruler in

traditional politics was the accumulator of interests and values, and responsible for the distribution of privileges and economic favours. Politically, the area comprised essentially two types of traditional systems – state and stateless (Dillon, 1990).

Understanding the evolution of curriculum and curriculum innovation in Cameroon is not possible without a history of context. As Waring (cited in Goodson, 1988) maintained,

> "If we are to understand events, whether of thought or of action, knowledge of the background is essential. Knowledge of events is merely the raw material of history: to be an intelligible reconstruction of the past, events must be related to other events, and to the assumptions and practices of the *milieu* (italics in original). Hence they must be made the subject of inquiry, their origins as products of particular social and historical circumstance ..." (p. 95)

The region today called Cameroon derived its name from a Spanish-Portuguese word "camarões."[2] As a political unit, Cameroon was created in the 1880s. Prior to that time there were numerous political entities in this area, each with its culture, history, government, and economy (Eyongetah & Brain, 1974; DeLancey, 1989). The pre-colonial period was dynamic, characterized by the migration of peoples, the rise and fall of governments, and economic relationships that tied together large numbers of the entities. However, conflict was a part of life, and war and conquest between African groups were common (Eyongetah & Brain, 1974).

Long before the annexation of Cameroon by Germany in 1884 or even prior to the arrival of the London Baptist Missionary Society in 1844, indigenous education in Cameroon focused on equipping the youth with essential skills as a form of

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[2] In 1472 the Portuguese sailor Fernua do Pao and his crew exploring the coast of West Africa found a variety of prawns swarming in the Cameroon river, and called the river *Rio dos Camarões* – meaning *River of Prawns* in Portuguese. In 1494, at the dawn of the New World, this region was later referred to as Camerones. This version was later anglicized to Cameroons. The Germans called it Kamerun while the French took this over as Cameroun. For more on the history and evolution of the name Cameroon, see Eyongetah & Brain (1974) or Njeuma (1989).

preparation for adulthood within the Cameroonian society (Eyongetah & Brain, 1974). Before European arrival during the 15th century, Cameroonians were divided into several viable kingdoms and chieftaincies that were busy providing for the needs of their populations (Azevedo, 1989). Pre-colonial (indigenous) education was essentially education for living, with its main goal being that of training the youths for adulthood within the society (Ngwang-Gumne, 2000; DeLancey, 1989). This form of education was less formal and its success depended on the unwritten rules and regulations that governed the choice of subject matter, the teaching strategies and the evaluation procedures that were laid down by the society (LeVine, 1964). These unwritten rules and regulations concur with current discussions on curriculum and curriculum policy by educators. Omulando (1992) maintains, "curriculum consists of the continuous chain of activities necessary for translating educational goals into concrete activities, materials and observable behavioral change" (p. 41). This implies that there may have been a prior debate about what passes as curriculum (and as curriculum theory), albeit non-formally, in pre-colonial Cameroon which was resolved in one way by the elders and then presented as a *fait accompli*, as a once and for all given since the values were part of what glued the community together.

There were no structures set up in the name of a formal learning environment, hence no formal schooling. However, most learning often took place in organized non-formal and informal settings such as evening family gatherings at the fire site for story telling. During this period, each of Cameroon's numerous ethnic groups[3] had evolved its own form of education. Adaptation to local climatic, topographic and ecological conditions, well reflected in the indigenous economies, guided this evolution. Emphasis was placed on normative goals, which were

[3] There are over 200 ethnic groups speaking over 230 languages in Cameroon. This heterogeneous ethnic mosaic – demographic, geographic and physical features – has led historians to describe Cameroon as a microcosm of Africa – an "Africa in miniature" wherein one can find all the major cultural types of the continent (See Dillon, 1990, for an extensive treatment of Cameroon polity.).

concerned with accepted standards and beliefs governing correct behaviour and expressive goals that were concerned with unity and consensus (Shu, 1985). The elders enjoyed the monopoly of instructing the youths based on their life experiences. This monopoly was rooted on the single fundamental principle of the supremacy of history as the source of legitimacy and power (political and mystical) (Dillon, 1990). This stemmed from a rather literal interpretation of the commonsense notion that older people or their representatives had a more precise knowledge because they had existed before those currently living and were seeing things before they were born. It was only common knowledge then that since the elders had lived longer than the youths, the success of the youths in life was thought to lie in learning from the elders and approximating, inasmuch as possible, the knowledge of the elders themselves (Dillon, 1990).

Using the concept of historical primacy as a source of legitimacy and power, each of Cameroon's numerous societies had established a reservoir of stories with legendary heroes through which moral lessons were transmitted (Eyongetah & Brain, 1974). For example, *'Wandong'*, *'Wafirmwa'ah'*, *'Tautsagha-Bahtum'*, *'Kebegha'* (fox, leopard, sense-pass-king, and the tiger respectively). These were stock characters in many stories from the Bantu and grassfield[4] settlers of the savannah region of Cameroon, through which children learned traditional values such as humility, honesty, courage, kindness, and respect (Shu, 1985). Each story had a moral lesson to be passed to the audience. Also common to most communities in the savannah region was the burial of the last piece of the umbilical cord as a form of connecting the child with their ancestors. This connection was to ensure protection

[4] The grassfields, a term that derives from the German colonial period refers to the well-watered highland savannah region in western Cameroon. It is bounded by forest to the east, south and west and drier country to the north (See Eyongetah & Brain, 1974, for an extensive description of the geography of Cameroon).

against evil spirits, guard against immorality and make the child spiritually whole (Eyongetah & Brain, 1974).

As the children got older, they were trained in skills that would ensure courage, endurance, self-control, patience and dignity, and skills that would introduce them to the direct service of the community. For example, the bridge from childhood to adulthood in the savannah communities of northwest Cameroon was marked by such traditional rites of passage as circumcision. Though a painful operation, it was often used to test for endurance and courage and as a formal occasion to inculcate the values of the society. The progressive introduction of subject matter as governed by the age of the children resonates with Piaget's stages of human development (Tambo, 1992). While Piaget acknowledged that chronological age is not the obvious determinant in the introduction of subject matter, mental readiness and sequential learning was certainly a crucial determinant to the gradual introduction of subject matter and guiding the child through to adulthood.

The general approach to the education of the child in the indigenous educational setting was on a communal basis with the parents of the child acting as the first teachers. Gradually, these responsibilities shifted to other family members and eventually to the entire community (Shu, 1985). The method of teaching took many forms again depending on the age of the children. At an early age, children were encouraged to learn through play and also by imitating the adult world in a creative and symbolic way. Learning through play, work, observation and imitation was premised on children's minds being like *tabula rasa*, the adult being the fount of knowledge, of definition and convention. This was based on certain assumptions derived from experience that the child had an inherent capability to structure sense impressions and a preferment for morally good acts rather than bad (Adelman, 1984). The children then often imitated their parents and other grown-ups activities which they would pursue at a later stage (DeLancey, 1989).

> A child who did not participate actively in play was normally suspected of being ill or even abnormal. Children were left to their own initiative to make toys. They made toys from local materials of their own choice and interests. They moulded from mud and clay and made use of articles which were of little use to adults. (Azevedo, 1989, p. 5)

Besides learning through play, other teaching methods such as story telling were often used. This was even more so because the indigenous education was totally oral. With these stories, the children were gradually equipped with the mental capability of understanding the abstract and applying that understanding to their own life. Through story telling, children also developed listening skills. This kind of learning was later reinforced by the language games the children often played such as riddles, proverbs, tongue twisters, transposition of syllables, or through nonsensically but musically arranged words (Eyongetah & Brain, 1974, p. 26). In their enactive theory of cognition, Varela, Thompson and Rosch (1991) characterize this kind of learning as "embodied". According to this theory of cognition, "embodied" refers to the sense of dependency by cognition upon sensorimotor capacities and these in turn upon a larger context of biological, psychological, and cultural influences. Thus using cognition as embodied action (Varela, Thompson & Rosch, 1991, p. 205), a youth would be thought as functioning adequately when they become part of the ongoing existing [external] adult world i.e. culturally, socially, spiritually and emotionally.

Another approach to teaching in the indigenous education setting was through apprenticeship (Dillon, 1990). Some children within the community were expected to assume special responsibilities such as being herbalists, mid-wives, weather forecaster, cleansing of the land, communicating with the ancestors. For example, a Bantu girl who eventually became a midwife most likely had a mother or grandmother who was a midwife, since midwifery was handed down in family lines within the Bantu culture (Dillon, 1990). Some of these responsibilities were

designated to particular children at birth to inherit the knowledge from a close relative who had been bestowed by the creator with that particular knowledge (Dillon, 1990). The apprentices learned by observation. Learning through apprenticeship was a life long process. Though the learner performed some duties in the presence of the instructors when they were thought to be knowledgeable and proficient (Dillon, 1990), they only performed independently once the instructor retired due to old age, got incapacitated or died.

This kind of indigenous education through apprenticeship and association to a particular community concurs with Lave and Wenger's (1994) discussion of *situated learning*. In their discussion, Lave and Wenger (1994), view learning in relational terms – as a form of legitimate peripheral participation. They maintain that, learning viewed as legitimate peripheral participation, "is not merely a condition for membership, but is itself an evolving form of membership" (Lave & Wenger, 1994, p. 53) to any given community of practice. Lave and Wenger (1994) believe that "the historical significance of apprenticeship as a form for producing knowledgeably skilled persons" (p. 62) in a given community of practice "has been overlooked, only because it does not conform to either functionalist or Marxist views of educational 'progress.'" (Lave & Wenger, p. 62). They write,

> "Apprenticeship has been treated as a historically significant object more often than most educational phenomena – but only to emphasize its anachronistic irrelevance. It connotes both outmoded production and obsolete education. When its history is the pretext for dismissing an issue as an object of study, there is good reason to reexamine its existing historical and cultural diversity." (p. 62)

It is clear from this description of indigenous education that it was firmly based on some philosophical foundation (DeLancey, 1989; Dillon, 1990), with functionalism as the main guiding principle. This kind of education was strictly utilitarian as an immediate induction into society and a preparation for adulthood.

There was a high level of communalism as another guiding principle. Children were brought up to value group cohesion rather than individual achievement because "freedom of the individual was completely subordinated to the interests of the clan... and cooperation was preferred to competition" (Dillon, 1990, pp. 43-44). Through education, members of the society made sure that values and skills necessary for the survival of the cultural heritage were learnt. In summary, indigenous education was education geared towards producing individuals with a strong and well-informed cultural identity. And just because indigenous education did not conform to the ways of the Westernized system, it is not the case for some less informed writers to have considered it primitive or inferior. Such contentions, Reagan (1996) maintains, should be seen as the product of ignorance and due to a total misunderstanding of the inherent value of informal education.

3.2.2 Colonial and Post-Colonial Education

The evolution of formal education in Cameroon may be divided into five cultural epochs that bear eloquent testimony to a very rich diversity in the influences at work on Cameroon history as a whole and on educational development in particular (Shu, 2000). First, there was the period of English Education from 1844 to 1886 under the Baptist Missionary Society. Next came the epoch of German Education from 1884 to 1914 when Imperial Germany explored and conquered the hinterland and thus established their authority of the entire region. The third and fourth eras which occurred concurrently were that of French Education juxtaposed with that of English Education from 1922 to 1961 (Shu, 2000). The fifth and last period is the post-colonial (post-independent) and reunification period from 1961 to present day. With these five eras, it is obvious that the philosophy of education varied with the change in the European power in control in Cameroon.

The arrival of the London Baptist Missionary Society (B.M.S.) in the 1840's signaled dramatic changes in ideology and philosophy of indigenous educational

setting. Formal institutions of learning were being initiated and established. The B.M.S. and other American and European missionary organizations "envisioned themselves as bringing a high view of life to benighted savages" (Beidelman, cited in Goodson & Ball, 1984, p. 118). Their main objectives in the provision of schools was not to educate Cameroonians but as an incentive for the Cameroonians to allow their children to be subjected to the missionary influence and hence convert them into 'Good Christians' (Ball, 1984). Hence, formal education became an agent of assimilation, exploitation and subordination.

In 1844 the B.M.S. led by Rev. Joseph Merrick established the first formal education setting in Cameroon. This was not an accidental occurrence but an outgrowth of a pattern of Christian missionary activities throughout West Africa at the time (Azevedo, St. Lawrence, 1989). Because the B.M.S.'s main objective was to spread Christianity, the kind of curriculum that was developed and implemented in this first primary school and subsequent ones was evangelical in nature, emphasizing a religious content. The medium of instruction was English with pidgin English as the lingua franca. Literacy skills were limited to the reading of the scriptures. The end result was to be the conversion of a few Cameroonians who would then assist in spreading the gospel as "interpreters, and priests" (Shu, 2000). The B.M.S. began achieving their objectives as more and more Cameroonians were attracted to school with the hope that they would stand a better chance of getting a white-collar job that went to the educated. The success of the B.M.S. led to an influx of missionary organizations from Europe and America to compete for converts. Prior to this influx, the B.M.S. had limited the content of the curriculum to catechistical religious knowledge. As Beidelman (cited in Goodson & Ball, 1984) maintains,

> "The missionaries were reluctant to teach secular skills to Africans because some feared to teach such skills would be to teach the wrong aspects of the world..."(p. 120)

Each of the missionary societies worked hard on attracting Cameroonians to their schools by modifying their approach to the kind of formal education offered. The Church Missionary Society (C.M.S.), one of the new missionary societies to establish in Cameroon after the B.M.S., played down the role of English as its medium of instruction, preferring to teach in the vernacular, but yet maintained a firmly catechistic curriculum (Ball, 1984). It did not take long for Cameroonians to become suspicious of the narrowness of this kind of curriculum as they turned to the Catholic Holy Ghost Fathers who taught other subjects beside religious instructions. Curriculum changes such as the use of vernacular languages for instruction by some of the missionary societies came as desperate efforts to attract and retain Cameroonians in their schools rather than as suggestions from the Cameroonians. Not surprising, there was no impact on this 'adapted' curriculum.

One of the missionary societies, the Basel Mission, found that it was only possible to establish themselves by making fundamental changes to the sort of schooling they were offering rather than to the curriculum (Eyongetah & Brain, 1974). For example, "they concentrated their efforts into boarding schools" (Ball, 1984, p. 119) – a deliberate policy of detachment of individuals from the traditional milieu – and "teaching exclusively in vernacular languages" (Ball, 1984, p. 119). The Baptist Boys School in Kumba, Joseph Merrick School in Bimbia, and the Girls Baptist School at Bonaku were such schools. These schools continue to exist in Cameroon till today. As the cost of running the schools increased the metropolitan government (colonial government and the missionary organizations, settlers, estate owners and traders), was forced to make drastic changes to their policy on education in the colonies. In 1847, the Education Committee of the Privy Council backed by the British government, issued its first systematic report to the Colonial Office in Cameroon. It stated,

> "A short and simple account of the mode which the Committee of the Council on Education considers that industrial schools for the colored

> races may be conducted in the colonies and to render the labour of the children available towards meeting some part of the expenses of their education" (Cited in Goodson & Ball, 1984, p. 123).

While each denomination taught aspects of its beliefs in the newly opened schools, increasingly strong control was applied by the colonial government in matters of curriculum. This control was enhanced by the British administration's 'grants-in-aids' under the system of 'payment-by-results' as recommended by the Education Committee of the Privy Council (DeLancey, 1989, p. 30). Such control by the colonial government meant that in general, the schools followed a program much the same as those throughout Nigeria and other British colonies, a program modeled after that used in Britain and based on the British philosophy of education (Ball, 1984).

The colonial government, it would seem, cared little about the culture and well being of indigenous Cameroonians. They viewed education as having a utilitarian and job-training role and hence supported an education system that produced a class of individuals who performed clerical and administrative duties required in various government and commercial sectors (Azevedo, 1989). The colonial government had created a need for formal education and then later established taxing conditions on its provisions. Meantime, the colonialists were busy collecting raw materials from Cameroon and exporting these to Europe to be converted into finished goods. These same finished goods such as guns were later on exchanged for tons of raw material produced by Cameroonians. This form of intellectual exploitation resonates with Willinsky's characterization of "intellectual mecantilism" as a form of exploitation wherein "the raw materials for grand theories are imported from the colonies for refinement and redistribution" (Willinsky, 1999, p. 59).

With the grants-in-aid programme as an incentive, the interests of the colonial government, the European settlers, and the missions appeared to coincide

and this gave rise to a relatively well-coordinated schooling system. The only group in this instance, which did not find its needs and interests being served, was the Cameroonians themselves (Ball, 1984). The Germans exacerbated this situation with the annexation of Cameroon in 1884. The parents who had always played a major role in determining what kind of education their children needed were not only to be sidelined and become mere observers to the changes made in the curriculum, but forced to send their children to be indoctrinated and alienated.

Cameroon's annexation by Germany in 1884 meant that Cameroon was now a part of Germany and this precipitated educational change in conformity with Germany's view of the purposes of the colonies. With complete control of the territory by Germany, there was a withdrawal of the predominantly English-speaking missionaries and a sudden infusion of Germanic people. Missionaries who had spoken the local languages and English were replaced with German-speaking arrivals who imposed German in the schools as a medium of instruction, without allowing a transitional period.

At the time the Germans arrived, formal education was in its infancy with about 300 Cameroonian children enrolled in the five mission schools that had been established (Azevedo & St. Lawrence, 1989). This was a period of confusion as all the schools were invariably conducted in German with limited use of vernacular languages in the early years of German rule. Cameroon was now under colonial rule proper. To reinforce German influence, the use of vernacular languages was reduced and German instruction intensified. To maintain this, financial grants from the colonial government to the mission schools were based upon the German language competency of the pupils. In addition, government scholarships were available to students who demonstrated competence in German for more advanced study in Germany (Azevedo & St. Lawrence, 1989). German policy on the nature of formal education in Cameroon was predominantly technical and vocational. Thus the

curriculum that evolved emphasized Germanic studies, and the immediate educational objective in view was to introduce indigenes to Teutonic Culture (Shu, 2000).

As Nyerere in "Education for self-reliance" argues, the purpose of education provided by the colonial government was not to prepare the youth for the service of their own country. Instead, it was motivated by a desire to inculcate the values and ideals of the colonial society and to train individuals for the service of the colonial state (Bishop, 1985, p. 237). Nyerere's argument resonates with Rodney's characterization of colonial education:

> "It was not an educational system that grew out of the African environment, or one that was designed to promote the rational use of material and social resource. It was not an educational system designed to give young people confidence and pride as members of African society, but one which sought to instill a sense of deference towards all that was European and capitalist." (Rodney, cited in Azevedo, 1989, p. 140)

External influences on Cameroon did not, however, begin with the establishment of colonial rule. That was directly preceded by periods of product and slave trade between the Cameroon coast, Europe, and North America, as well as the beginnings of a wide spread Christian missionary movement in the area (DeLancey, 1989). However, with the annexation of Cameroon by Germany on July 14, 1884, there followed a brief period of competition among European countries, mainly to make treaties with as many local chiefs as possible to gain control of the land and trade, as per the agreements of the Conference of Berlin—an international meeting on the European colonization of Africa. Germany's control over Cameroon was, however, short-lived. A few years after the first formal educational conference in Cameroon in 1907 in which Germany re-emphasized its commitment to German-speaking instructions in all the schools, they were ousted by British and French at the beginning of World War I (Azevedo, 1989, p. 140). Quite abruptly, German

ceased to be taught in the schools, and German printed materials disappeared. Overnight, English and French became the official languages and the instructional languages in the respective geographic areas occupied by each country. During the linguistic confusion which followed this transition, pidgin was used to span the gap as people resorted to whatever languages would enable communication (Azevedo, 1989).

In the French occupied areas, schools were supervised by the French army chaplains and education was based on French values and ideas about education and the education process (Eyongetah & Brain, 1974). The French viewed education as part of the process of converting Cameroonians into francophones. The *mission civilisatrice,* the view that France's role was to bring its culture to a waiting world eager to adopt that culture, was a significant current in French colonial thought. Thus, the French saw no role in the education process for Cameroonian languages or culture (DeLancey, 1989, p. 141). While vernacular languages were tolerated, they were not encouraged and were sometimes punishable when expressed in the classroom (Eyongetah & Brain, 1974; Njeuma, 1989).

Denying the children the use of their language had one aim: to make them despise their language, hence the values carried by that language, and by implication despise themselves and the people who spoke a language which now was the cause of their daily humiliation and corporal punishment. Colonial education appears in this context as a process of denying the national character, alienating the Cameroonian from her/his country and origin and, in exacerbating her/his dependence on abroad, forcing her/him to be ashamed of her/his people and culture.

From the time the French arrived, the curriculum and the syllabi became French. The French saw little need for local variations in curriculum; strong central control was exerted from the colonial office in Yaounde and from Paris. Educational support from the government was dependent upon the mission school's adherence to the French educational system. To ensure that the graduates from these schools

were assimilated into the French culture, the French limited the provision of education facilities up to the secondary while granting scholarships for Cameroonian students (mostly to the sons and other relatives of the chiefs and kings) to continue their education in France. It was thought that by limiting access to post-primary education and the literary/academic curriculum, they would be able to reproduce and control a neo-traditional native elite and avoid the creation of an employed educated group. When questioned by the United Nations in the early 1950s, on why no university had been established in Cameroon, the French responded that Cameroonian higher education did exist – in France (Azevedo, 1989, p. 141).

In contrast to the French-occupied areas, the British sectors adjoining Nigeria reflected pre-colonial policy and encouraged instructional use of vernacular languages in the early years followed by English instruction at the higher levels. Under the British colonial rule, education in the British controlled territory was largely delegated to the Nigerian government. This meant that in order for Cameroonians in this region to receive training at the secondary or technical levels, they had to travel to Nigeria, a trend that continued well after independence (Shu, 2000).

The British believed that they were educating Cameroonians to be Cameroonians – useful in cash crop and other raw material production – and not attracted away from the land into the modern sector of the colonial economy. This was clearly spelt out in the report of the Committee of the Council on Education which stated among other recommendations, that the principal objectives of the education of the natives in the colonies should be: (1) to diffuse grammatical knowledge of the English language as the most important agent of civilization; (2) improved agriculture is required to replace the system of exhausting the virgin soils and then leaving the natural influences alone the work of reparation. The education of the colored races would, therefore, not be complete for the children of small farmers, unless it included this object; and (3) lesson books should teach the natural

interests of the mother country, and her dependencies, the natural basis of this connection and the domestic and social duties of the colored races (Ball, 1984, p. 124). In this connection, they tolerated the use of Cameroonian languages in the early years of primary school followed by increasing instruction in English in the higher levels (Azevedo, 1989). Unlike in the French occupied territories where the French exerted strong central control in the organization of the school, the British left more discretion in the hands of local school officials. The students in schools prepared for similar examinations written by students in London and other British colonies (DeLancey, 1989).

The report of the Education Committee was the first in a continuing series of failed attempts to 'adapt' the school curriculum in British controlled Cameroon and other colonies. Foster points out that the failure of the recommendations rested on two assumptions: first, that 'the creation of schools and curriculums' based on the economic development of agriculture 'would generate demand for such education among the "colored races"' (Foster, cited in Goodson & Ball, 1984, p. 125); and secondly, that 'African expectations regarding the potential functions of educational institutions were congruent with those of Europeans, or could be made so' (Foster, cited in Goodson & Ball, 1984, p. 125). The failure of these recommendations is undoubtedly evident, as the colonial government had overlooked the contribution of the indigenous Cameroonians to the establishment of the schools.

The failure of the Privy Council report precipitated another series of evaluation reports. One of such reports was that produced by the British government appointed Phelps-Stokes Commission, an American funded investigation into the African education which visited West and South Africa in 1921 and East and Central Africa in 1924. According to Ball (1984), "the reports, *Education in Africa: A Study of West, South and Equatorial Africa by the African Education Commission* (1922) and *Education in East Africa* (1925) written by Jesse Jones, were very much influenced by the work of black American educators at the Hampton and Tuskegee Colleges.

Parallels were drawn between the educational problems of the American Negro and the African. With this transfer of concepts, the emphasis of the reports was on the role of *rural education*" (Goodson & Ball, 1984, p. 132). This report was to become the guiding document on overcoming Cameroonian resistance to the 'adapted', narrow, and academically oriented curriculum. According to the report (cited in Goodson & Ball, 1984, p. 133),

1. the schools were to be adapted to native life;
2. emphasis was to be technical vocational and agricultural training at the expense of more 'traditional' subjects within the curriculum;
3. there was to be an increase awareness of the need to expand educational facilities for women and girls.

These recommendations meant that major changes were to ensue in the contents of certificate and matriculation examinations organized by the British government for all its colonies. At the instigation of the Colonial Office Advisory Committee, the University of London passed that,

> "the English universities involved in overseas examining expressed a willingness, in the best tradition of the Phelps-Stokes, to modify their syllabuses 'in order that the external examination system might be adapted to local needs' and to ensure that colonial subjects were 'not being forced into an educational mould that might deform their particular attitudes' and unfit them for a life in their own country" (University of London, Minutes, 1935-36).

Graduates from the French and British colonial schools who had hoped for better jobs and hence better lives soon realized that there were no openings for them. They had seen education as the one source of the material superiority of the white colonialists, and a route for individual social mobility. Courade and Courade (1975) quote two extracts from essays written in 1930 by Alliance High School pupils under the title 'Why I Go to School';

> If I go to school and get much knowledge I would not always work for others but I may have much money, I will look for many workmen.
>
> I myself want to go to school. But every boy who does not want to go to school is stupid. You can't be a great man without going to school. If you want to be a great man then go to school. (Courade & Courade, 1975, p. 10)

Even with this education, Cameroonian graduates realized that their aspirations were some what far fetched. The position and jobs in the colonial government was restricted mostly to the whites with a very few lucky Cameroonians appointed to posts of responsibility. Frustrated by competition in the important roles in the administration, kept down by whites in the missionary groups, these graduates of the primary and secondary schools came to see that the continuation of foreign domination meant their continuing relegation to the lower posts, the lower pay, the lower profits (DeLancey, 1989). Only through independence was there a chance to open those opportunities for Cameroonians. Events leading up to independence were set in motion in 1955. In that year, Southern Cameroons (formerly West Cameroon) withdrew from the Cambridge University Board to take the West African Certificate Examination which had been created in 1951 (Ndongko & Nyamnjoh, 2000).

At the dawn of independence, when colonial regimes were being ousted from the African continent, Cameroon, like most African countries (e.g. Nigeria, Ghana, Chad, Sierra Leon, etc) had a literacy rate of 10 percent (DeLancey, 1989). The rate of educational expansion had not been even as some schools were more equipped than others based on the 'grants-in-aid' program and on the performance of their graduates in the French language. As a Federal Republic, made up of the British West Cameroon and the French East Cameroon, it had inherited two systems of education – the French and the British. With these two systems of education founded on two different and competing philosophies, integration and consequently harmoniz-

ation was to become one of the major tasks in Cameroon's drive towards literacy for all Cameroonians (Tambo, 2000).

Independence for Cameroon as for most of Africa, did not come easily. There were negotiations, agreements, treaties and concessions made by both the colonial government and the government of independent Cameroon. There were agreements signed between the British government and West Cameroon. In the first agreement in 1963, Cameroon agreed to withdraw from the West African Certificate Examination and to follow the University of London General Certificate of Education (G.C.E.) Examination. Similar agreements were signed between the French government and East Cameroon. One of such was the 1959 agreement between Ahidjo and the French government in which Ahidjo, as the father of independence, was to maintain close cooperation in economic, cultural, political, and military affairs (Beuth, 1975). Through this agreement, a system had been established whereby the two European powers got their raw materials and sold their finished goods. In East Cameroon, the French had imported printing presses in order to produce instruction materials in French. The educational system was well-organized in this part of the country. In the West, the educational system had virtually collapsed. Primary education had developed slowly and higher education was available only in Nigeria, which maintained strict quotas for Cameroonians (Azevedo, 1989). Besides these differences in education provisions in the two regions, Cameroonians began the work at harmonizing and standardizing the structure and organization of the two systems. In 1976, the Cameroon government organized a national education seminar with representatives of the British government. Important decisions were made in this seminar regarding the British system of education:

> "The main features of the examination such as name, organization, objectives of the ordinary level and advanced level subjects, number of sessions, per year, types of questions, marking, grading, security measures, etc. were defined...It was agreed that special link arrange-

> ments be established with the Department of Examinations, Senate House, University of London and the British Government. This involved assistance in drafting of the syllabuses, moderation, the supply of consultants and external examiners and the training of the Cameroonian personnel. Finally, it was agreed that subject to the maintenance of appropriate standards, the University of London would be asked to do all that it could to ensure the wide scale recognition of the Cameroon G.C.E. examination." (Ministry of National Education, 1976, pp. 34-35)

Since the Cameroonization of the G.C.E. there have been a series of reforms by the Ministry of National Education to harmonize the G.C.E. with the French Baccalaureate. Most of these reforms were not successful, as concession was demanded only of the English-speaking Cameroonians. The French-speaking section strictly followed the baccalaureate as organized in France, and students who pursued their studies in French wrote the baccalaureate and/or the G.C.E. examination with the hope of studying abroad in a French university.

Even with Cameroonians now at the helm of all the institutions in the country, the school curriculum remained unchanged. The school curriculum, totally foreign to the people of the Cameroons, emphasized disciplines and training that did not address themselves to the needs of the indigenous population (Eyongetah & Brain, 1974). Neither was the curriculum based on the culture of the Cameroonian society, through which the young could be socialized, nor was it framed in terms of what was regarded as being best or most valuable among the intellectual and artistic achievements of the Cameroonian society. The curriculum employed, though controlled by Cameroonians, was essentially European in nature, grounded within theories of education that gave rise to a view of knowledge as timeless, objective, owing nothing to the particular circumstances of individual eras, societies, cultures or human beings (Shu, 2000). Concentration was on the history, geography and the language of the mother country (English and French) and acquisition was accom-

plished through constant memorization. Rodney (cited in Azevedo, 1989) poignantly noted that:

> "... the colonial system educated too many fools and clowns, fascinated by the ideas and ways of life of the European capitalist class. Some reached a point of total estrangement from African conditions and the African way of life ... Colonial schooling was education for subordination, exploitation, the creation of mental confusion, and the development of underdevelopment." (p. 140)

This is reminiscent of my elementary school history text in the late 1970s and books on the history of Cameroon that often opened with the following: "The Carthaginian Adventurers were the earliest to discover Mount Cameroon..." (Eyongetah & Brain, 1974, p. 9). As if Cameroonians had not seen Mt. Cameroon, the highest peak in West Africa, which was in active eruption at the time. Mt. Cameroon was the worshiping place for the Bakweri people of southwest Cameroon. To say that the Carthaginians led by the north African Hanno (Eyongetah & Brain, 1974), were the first to see this conspicuous physical feature is to imply that the communities which had lived in these area for hundreds, if not thousand, of years were blind or not "men". Such knowledge was used and continues to be used to show the superiority of a race that had the ability to name the world for the Other. It is worth noting that Mt. Cameroon is locally known as Mt. Bwea, named after the tribe that had settled there hundreds or thousands of years ago (Ardener, 1996, p. 52). This sense of superiority for one race and the consequent inferiority of the other race is presented as "the" objective fact in order to perpetuate the status quo.

Having little or nothing to identify with, the learner passively listens to the teacher talk, ready to recite and reproduce the teacher's notes in the exam. The learners memorize mechanically the content which turns them into "containers" or "receptacles" to be "filled" by the teacher (Freire, 1994, p. 53). This kind of teaching is what Freire (1994) refers to as "banking concept of education".

> "Education thus becomes an act of depositing, in which the students are the depositories and the teacher is the depositor. Instead of communicating, the teacher issues communiqués and makes deposits which the student patiently receives, memorizes and repeats." (p. 53)

As a high school mathematics teacher, I remember questions in the mathematics texts drawn from cultures very alien to Cameroonians requiring students to problem-solve. For example,

> "If a cricketer scores altogether r runs in x innings, n times not out, his average is $r/(x-n)$ runs. Find his average if he scores 204 runs in 15 innings, 3 times not out." (Bishop, 1990, p. 55)

While some of the students were able to solve the problem and others similar to these, with their good knowledge of algebra, most never understood what the problem was all about. What is an inning?, a run? What is the game of cricket all about? were questions teachers could not provide answers to. But since the teachers are viewed as the most knowledgeable persons in the classroom, it meant that the students could not pursue such inquiry further than the teacher was prepared to. This is a good problem to encourage students' application of concepts but they serve no purpose if the concept is entirely developed with examples like these. The end result is, students finding it difficult to construct any understanding with no experiential knowledge.

Consequently, the evaluation process becomes a continuous source of anxiety for the learners. With a curriculum or more appropriately, a syllabus that concentrates on imparting knowledge that will be tested in an exam, it is little wonder that certificates become the top priority and almost the sole determinant in the job market. And since Cameroon inherited in full measure the colonial educational tradition, the pervasive hold of irrelevance and inappropriateness calls for re-examination and re-statement of educational aims, goals, and objectives (Tambo, 2000).

While there has been some progress in educational provision, almost forty years after independence, the situation has not changed by much. Although there has been recorded dramatic improvement in terms of expansion in educational facilities and an increase in the proportion of school-age children in school (DeLancey, 1989, Tambo, 2000), yet illiteracy among adults remains common. Very little attention is paid on educating the adult populace. The accomplishment in the expansion of education for the youths has not come without several problems, some common to other African states, some peculiar to Cameroon. For example, for all children in Cameroon, education is either in French or in English, yet most of these students come from homes where these languages are not spoken. As a result, there is a high dropout rate after each academic year, partly due to linguistic difficulties, and partly to lack of basic school needs.

The traditional curriculum emphasizes physical education and musical education at the nursery schools, the three R's in the primary level, and classical education at the secondary level to prepare students for the G.C.E. and Baccalaureate examinations (Azevedo, 1989). The curriculum is heavily influenced by the examinations which lead to certificates. Initially aimed at preparing students to continue their studies at universities in France and the UK, the curriculum has continued to turn out these graduates even though the chances of studying abroad have become fewer and fewer. This therefore calls for Cameroon to re-think and re-formulate its educational policy to make formal education relevant and useful to the Cameroonian society.

3.3 The Current State of Education

In the current state of education, teaching and learning are heavily guided by examination syllabuses that provide a list of topics, theorems, and computations which 'candidates' need to know and execute (CGCE Board, 1994). Ndongko and Nyamnjoh (2000) describe the current school curriculum as based on the "academic-

elitist tradition of education inherited from the colonial educators" (p. 246). Ngoh (2000) also characterizes the curriculum as examination-oriented and geared towards "university preparation and white-collar jobs with undue emphasis on cognitive development at the expense of social skills, cultural and technological literacy" (p. 161).

The very high dropout rates after each year of school and an equally unfortunate high failure rate in the terminal examinations at each level of education suggest curricular problems than the quality of teaching in Cameroon today. The curriculum basically aims at preparing children to go to university, rather than preparing them for the life that the majority of them, unable to gain university admission, will live. To this end, emphasis is placed on the arts, humanities and social sciences at the expense of mathematics, science and technology. A clear indication to this current predicament is the large number of school-leavers who, after several years of hard work to meet the schooling demands still cannot find employment – or are not willing to accept the types of employment available.

It is easy to understand why school-leavers are unable to find employment having been educated in English and/or French, about the history concerned with how people lived in societies very distant in space and time, students complete their schooling with disdain for their own society and few, if any, marketable skills (Samoff, Metzler, & Salie, 1992). This is the kind of curriculum that does not inspire learning as school knowledge does not build upon the tacit knowledge derived from cultural resources that the student already possesses (Aronowitz & Giroux, 1991). Thus, designing a curriculum for the needs of the country, a national curriculum, is a goal of most African states, which unfortunately, inherited from their colonial rulers a set of educational practices and philosophies based on the needs of that ruler, rather than on local priorities and culture. For Cameroon, this situation is more difficult because of its dual inheritance. "Harmonization," the joining together of French and British educational theory and practice (Ndongko & Tambo, 2000), has

made more difficult the task of Cameroonizing the curriculum. Yet this dual inheritance may also hold a unique possibility of bringing together in the new Cameroon educational system a wider variety of experience than in other African states.

While education today in Cameroon remains heavily influenced by its colonial cultural heritage (an experience that cannot be ignored nor dispose of easily) as well as a multiplicity of vernacular languages, religious heterogeneity, and diverse ethnology (Shu, 2000), one of the distinct effects of the recent emergence of post-colonial discourse has been to force a radical re-thinking and re-formulation of forms of knowledge and social identities authored and authorized by colonialism and western domination (Mongia, 1996). I think Cameroon needs to re-think its educational policy and focus on designing a curriculum that will assist Cameroonians in the drive towards self-reliant development. This kind of curriculum will need to have [Cameroonian] culture as its central focus, be free of past colonial domination and yet be comparable with the rest of the world. It will be a curriculum derived from sources with which learners can identify and realize their contribution in the development of their country.

One of the ways Cameroonians can break away from this cycle of inappropriate education is by identifying individual characteristics and behaviours that are valued in the society, analysing them, and according to priority, developing a curriculum that would develop such individuals. To do this, the Cameroon government needs to get all those involved in the education of the child participate in crucial decision making sessions regarding the curriculum. The role of the parents need to be emphasized, and most importantly input from the students should be considered since they are the ones who are going to be affected most.

In this section, I have traced the evolution of the school curriculum in Cameroon from the time of pre-colonial Cameroon to post-independence. The understanding of the series of conflicts, compromises, and the various processes of

negotiations, through time, of the present curriculum will enable Cameroonians realize that failure to treat culture/society as a fundamental determinant to curriculum decisions is a major contributor to cultural alienation. Cameroon already seems to be making some great strides as evident in the recommendations of the 1995 National Education Forum and most recently in the 1999 National Education workshop. The 1995 Forum was the first of its kind since independence involving representatives from all the ten provinces as well as from private and lay secular education. The delegates at the forum stressed the need to harmonize the two systems, the need for the government to encourage the production of textbooks, and above all, the continual revision of the school curriculum to serve the needs of Cameroonians (MINEDUC, 1995, p. 67). What has the literature informed us about the cultural aspects of mathematics and mathematics learning and teaching? This is where I turn to now to review and discuss some studies on ethnomathematics.

3.4 Studies on Ethnomathematics

Much has been written about relationships between culture and mathematics. The writings span a range of topics that include the cultural bases for mathematics, mathematics development in different cultures, the historical culture of mathematics, the effects of culture on mathematics learning and dispositions toward mathematics, and the political effects of mathematics and mathematics education on societies. But research studies framed as ethnomathematical are few and varied, dating back to the early 1980s. As such, research in this area is in its infancy relative to other areas of research in mathematics or mathematics education. The conceptual, philosophical and theoretical explorations of ethnomathematics in the previous chapter (Chapter 2) have set the stage for identifying ethnomathematical studies to be reviewed in this section. Generally, research in ethnomathematics is driven by three broad questions: (1) Where do mathematical ideas come from, how are they organized?; (2) How does mathematical knowledge advance?; and (3) Do these ideas

have anything to do with the broad environment, be it socio-cultural or natural? (D'Ambrosio, 1994).

Barton (1996), however, classifies research in ethnomathematics in three dimensions: *time, culture,* and *mathematics*. "On the time dimension, ethnomathematics may be concerned with conceptions of an ancient or a contemporary cultural group" (p. 220). It also may be concerned with historical or contemporary practices of a cultural group. Examples might include research on how early settlers in Cameroon used mathematics or on modern-day Cameroonian entrepreneurs' use of mathematics. "The cultural dimension of the definition extends from a distinct ethnic group, to a purely social or vocational group" (Barton, 1996, p. 220). Research on this dimension may focus on African Canadians in British Columbia, Children selling candy on the streets of Brazil, sports statisticians in the National Hockey League (NHL) in North America, or teachers in adult literacy. "The mathematical dimension of ethnomathematics is determined by the relationship of the mathematical ideas to mathematics itself, i.e., ethnomathematics is a study which may be internal to mathematics, or conceptually removed from existing mathematical conventions" (Barton, 1996, p. 220). Examples of this dimension might include the varied formal conceptions of mathematics held by Cameroonian teachers or the mathematics used by craftsmen in Cameroon. Below (Fig. 3.1) is a modified illustration[5] (Barton, 1996) of these three dimensions and how they might interact.

The body of literature on ethnomathematics incorporates research on the mathematics practice of *identifiable cultures* and research on the mathematics practice in *everyday situations within particular cultures.* In the first case, researchers have tended to look at the mathematics practice of a whole culture (e.g., Bockaire, 1988; Carraher, Carraher & Schliemann, 1987; Gay & Cole, 1967; Gerdes, 1988; Lancy, 1983;

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[5] For more on the representation of the dimensions of ethnomathematics research see Barton, 1996.

Posner, 1982; Zaslavsky, 1973), whereas researchers investigating mathematics practice in everyday situations (Ascher, 1991; Barta, 1995; Saxe, 1985; Silverman, 1994) have focused on one situation or work context (e.g., grocery shopping, carpentry, masonry, candy selling) within a culture.

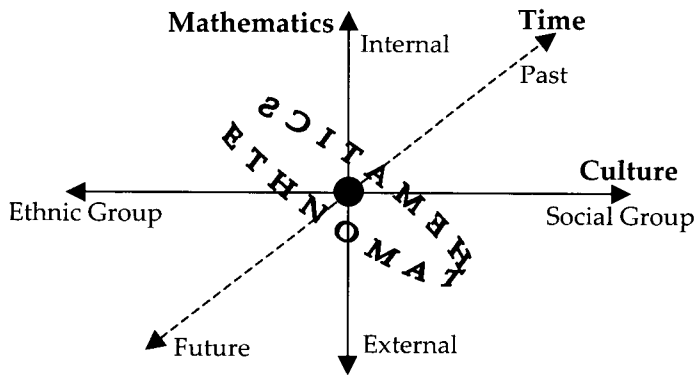

Fig. 3.1: Dimensions of Ethnomathematics Research

Some of these researchers (e.g., Barta, 1995; Brenner, 1985; Carraher, Carraher & Schliemann, 1987; Ferreira, 1990; Masingila; 1994) have contrasted mathematics practice in school with mathematics practice in everyday situations and noted the gap between the two. Lester (1989) suggested that knowledge gained in out-of-school situations often develops out of activities that occur in a familiar setting, are dilemma driven, are goal directed, use the learner's own natural language, and often occur in an apprenticeship situation. Knowledge acquired in school all too often is formed out of a transmission paradigm of instruction that is largely devoid of meaning. In mathematics, this process of knowledge acquisition has been referred to as acculturation – the process by which a social group, and ultimately each of its members, actively constructs mathematical knowledge on the basis of experience in a sociocultural environment that is not their own – and ethnomathematical studies have shown that this process often leads to intellectual impasses in the learner. As Knijnik (1997) reaffirms,

> When a specific subordinate group becomes conscious of the economic, social, and political disadvantages which its scarce knowledge brings about, and tries to learn erudite knowledge, this type of consciousness may contribute to the process of social change (p. 409).

I now review ethnomathematics studies that aim at providing some insight into the above three questions that researchers in this area concern themselves with.

3.4.1 Where do mathematical ideas come from, how are they organized?

The anthropological literature (Ascher, 1991; Gerdes, 1988b & 1994; Masingila, 1994; Saxe, 1988; Zaslavsky, 1973) demonstrates that the mathematics, which most people study in contemporary schools, is not the only mathematics that exists (Lumpkin, 1983). Paulus Gerdes, a Mozambican mathematician and mathematics educator, is perhaps one of the leading researchers in uncovering the mathematical ideas embedded in African cultural practices and artifacts and in presenting these findings to the mathematical community. In looking for ways in which one can understand students' cultural ways of producing and expressing their mathematics, Gerdes and his colleagues in Southern Africa have "developed a methodology that enables one to uncover in traditional, material culture some hidden moments of geometrical thinking" (Gerdes, 1988b, p. 140). In their methodology, they "looked to the geometrical forms and patterns of traditional objects like baskets, mats, pots, houses, fish-traps, and so forth and posed the question: *why* do these material products possess the form they have?" (Gerdes, 1988b, p. 140) Observing the production techniques, Gerdes and his colleagues found that "the form of these objects is almost never arbitrary, but generally represents many practical advantages and is, quite a lot of times, the only possible or optimal solution of a production problem" (Gerdes, 1988b, p. 140). According to Gerdes, "the traditional form reflects accumulated experience and wisdom. It constitutes not only biological and physical knowledge about the materials that are used, but also mathematical knowledge,

knowledge about the properties and relations of circles, angles, rectangles, squares, regular pentagons and hexagons, cones, pyramids, cylinders, and so forth" (Gerdes, 1988b, p. 140).

"Applying this method," (Gerdes, 1988b, p. 140) Gerdes and his colleagues have unveiled "a lot of '*hidden*' or '*frozen*' mathematics." (Gerdes, 1988b, p. 140) They see "the artisan, who imitates a known production technique, (Gerdes, 1988b, p. 140) as, "generally, not doing some mathematics. But the artisan(s) who discovered the technique, *did* mathematics, was/were thinking mathematically. When pupils are stimulated to *reinvent* such a production technique, they are doing and learning mathematics" (Gerdes, 1988b, p. 141). This is however, dependent on the abilities and convictions of the teacher. As Gerdes and his colleagues state: "Hereto they can be stimulated only if the *teachers* themselves are conscious of hidden mathematics, are convinced of the cultural, educational and scientific value of rediscovering and exploring hidden mathematics, are aware of the potential of 'unfreezing' this 'frozen mathematics.'" (Gerdes, 1988b, p. 141).

According to Gerdes, the incorporation of this "frozen mathematics" like the Angolan sand drawings into the school mathematics curriculum provides the potential for the achievement of three important societal goals: (1) it may contribute to the revival, reinforcement and valuing of this practice and towards a more productive and creative mathematics education, as it avoids socio-cultural and psychological alienation; (2) the integration of this practice, the knowledge it reveals and its mathematical potential, will become less monopolized, less regional and less tribal and will contribute to the development of a truly national culture of Angola; and (3) its incorporation will lead to the consolidation of the idea that mathematics does not come from outside African cultures and this will contribute to mathematical confidence that has been long lacking in most of the non-European countries (Gerdes, 1988, pp. 19-20).

The argument that children make sense of the world according to their cultural background has been repeatedly supported, in many contexts, among students in Liberia (Gay & Cole, 1967), Sierra Leone (Bockaire, 1988), and Brazil (Saxe, 1988; Silverman, 1994). In Sierra Leone, for example, "Bockaire (1988) developed a project to 'investigate the mathematics that existed in Mende culture, the strengths and limitations of such mathematics, the mathematics that probably existed long before formal schooling was introduced in the Mende land' (p. 1). Bockaire was aware that, as a consequence of engaging in and reflecting on traditional activities, 'at the village levels, on the farms, at the rivers and on the foot paths or roads to their work place,' people develop mathematical understandings, albeit not in the same codified form as 'Western' mathematics. Cognizant of severe limitations in the colonialist-inspired school system, the aim of the ethno-mathematical investigation of Bockaire and his team was to create a culturally appropriate curriculum to educate those in the illiterate and innumerate sectors since 'mathematics courses in [Sierra Leone's] formal school system are structured without recognition and exploitation of the wealthy mathematical activities within the culture' (p. 1). In addition to contributing to the education of illiterate farmers, investigators used the Mende's approach to adding two sets of objects to teach, at Njala University College in Sierra Leon, the concept of homomorphism to a sophomore-level course in abstract algebra and noticed marked improvement in understanding and interest (p. 63)" (Cited in Powell & Frankenstein, 1997b, p. 256-257).

A number of research studies have demonstrated some encouraging results with the introduction of ethnomathematics into the mathematics classroom. Gerdes (1988) studied the sand drawings of the Tchokwe people of Angola and suggested some possible ways for using these in the mathematics classroom. From the sand drawings, Gerdes was able to demonstrate the presence of diverse arithmetical relationships such as arithmetic progression, series summation, and the Pythagorean

triplet. Other geometrical ideas observed and identified in these traditional Angolan sand drawings included geometrical symmetry (bilateral symmetry, rotational symmetry, double bilateral and point symmetry) and similarity. The existence of these properties suggests that the sand drawings could serve as a starting point for the teaching of geometrical symmetries and similarities. Contrary to arguments made against ethnomathematics as 'not real' mathematics, Gerdes was able to use one of the sand drawings, the 'akwa kuta sona', to show how its physical properties (characteristics of the curves) could be used to determine the greatest common divisor (GCD) of two natural numbers. An awareness of these characteristics in the determination of the greatest common divisor of two natural numbers establishes a solid foundation for the learning of other mathematical concepts and relationships such as the Euclidean algorithm in the determination of the greatest common divisor of two natural numbers. The extrapolation of the concept of GCD achieves two goals: (1) it demonstrates in the learner the presence of mathematical concepts in their culture, (2) it demonstrates that mathematics is a mosaic of cultural contribution, and (3) allows the learner to better appreciate the subsequent refinements made of the mathematics concepts. Gerdes maintains that the incorporation of these traditional Angolan sand drawings, both educational and artistic-mathematical, into the curriculum may contribute (1) to the revival, reinforcement and valuing of the practice; (2) towards a more productive and creative mathematics education, and (3) to the development of a truly national culture by including other popular practices from all regions of the country. Gerdes' analysis can be applied to different cultural contexts worldwide.

3.4.2 How does mathematical knowledge advance?

Henderson (1981) argued that many people viewed and learned mathematics in a rigid and rote way that has hindered their creativity. This condition is further "systematically reinforced by our culture, which views mathematics as only

accessible to a talented few. These views and attitudes, besides affecting individuals, have become part of what separates and holds down many oppressed groups, including women, working class and racial minorities" (p. 12).

A study conducted by Saxe (1985) in an effort to gain insight into the influence of Western schooling on the development of arithmetical understandings in children from a non-technological culture, the Oksapmin of Papua New Guinea, showed that Oksapmin children not only spontaneously use the indigenous system in the context of school arithmetic, but also have created new forms of numerical symbolization and calculation based on that system to deal with the arithmetical problems in formal instructional setting. This phenomenon with the Oksapmin children is quite general and occurs in other ethnic groups as they apply knowledge they have generated in their everyday social activities to the novel problems they identify as they participate in Western school classrooms.

In their study of the mathematics learning difficulties among the Kpelle of Liberia, Gay and Cole (1967) concluded that cultural differences are not necessarily associated with deep cognitive differences and that there do not exist any inherent difficulties: what happened in the classroom, was that the contents did not make any sense from the view point of the Kpelle-culture; moreover the methods used were primarily based on rote memory. Instead of taking school knowledge as the reference and elaborating tasks from this perspective to see whether individuals transfer it to other settings, the researchers used ethnographic observations outside school contexts. They organized research tasks based on activities within the community studied. The results showed that differences in favour of schooled western people in tests (generally showing a 'decalage' of several years' advantage over natives from non-western cultures) disappeared. In some cases, these differences appeared in the opposite direction. For example, Kpelle illiterate adults performed better than their North American counterparts, when solving problems such as the estimation of number of cups of rice in a given container, that belong to

their indigenous mathematics. With these results, Gay and Cole became convinced that it is necessary to investigate first the "indigenous mathematics," in order to be able to build effective bridges from this "indigenous mathematics" to the new mathematics to be introduced in the school. According to Gay and Cole, this ethno-mathematical approach calls for the teacher to begin with the materials of the indigenous culture, leading the child to use them in a creative way, and from there advance to the new school mathematics.

3.4.3 *Do these ideas have anything to do with the broad environment, be it socio-cultural or natural?*

Vygotskian perspective contends that culture influences individual development. Vygotsky believed that "creative imagination" grows out of the play of young children (Williams, p. 117) and that learning occurs at two levels: the social level in collaboration with others, and the individual level, where learning is internalized (Vygotsky [1934], 1978). Therefore a rich learning environment provides a stimulating place for meaningful interactions to occur and concepts to form at the everyday or spontaneous level.

From this viewpoint, the meanings of many mathematical concepts are socially or culturally determined and at times the meaning of a word may vary according to the sociocultural context in question. FitzSimons et al. (1996) noted that the term 'numeracy' has been used to carry different meanings and its meaning varies according to the social and cultural background of its users. In general, the term 'numeracy' is used more often in the Anglo-American countries while the term 'mathematics' is used in the German speaking countries. Generally, "being numerate means having developed certain basic mathematical skills applicable to various situations in everyday life" (FitzSimons et al., 1996, p. 756). On the other hand, to be 'mathematically educated' encompasses a broader perspective. It means to "have a sound mathematical knowledge", to have "acquired knowledge about concepts and

methods typically utilized in mathematics - about their power, and about their limitations" (p. 756) as well as to have a critical stance about mathematics as a whole. In sum, *numeracy* is regarded as only an important part of *mathematics* that is required by any individual to function relatively effectively in every day life situation.

Boaler (1993) conducted a study in the UK that considered the influence of context upon students' choice of procedure as well as a comparison of the relative effectiveness of two environments (one characterized by the complete integration of process and content with one that concentrated mainly upon content with some separate attention to process) with relation to a student's capability in situations requiring transfer to the 'real world'. In contrasting the effectiveness of the two learning environments, Boaler presented students with questions set in different contexts and investigated whether their capability in transferring their mathematics was related to the way they had learned mathematics. She observed that while the methods students used in the questions did not reveal any particular reason for differential response, it did confirm their variance in methods with contexts. It was also observed that procedure and performance were, to some extent, determined by the task contexts. This research highlights the importance of context in learning, as this provides bridges and helps break down barriers to growth in mathematical understanding.

Boaler's (1993) study corroborates findings of an earlier study conducted by Carraher et al. (1987), which investigated the effect of the situation on the choice of procedures and efficiency in problem solving with 16 third graders aged 8-13, in Recife, Brazil. During the interview sessions, each child was asked to solve 10 problems in each of three different situations: (a) simulated store situation in which the child played the role of the store owner and the experimenter played the role of customer, (b) embedded in word (story) problems, and (c) computation exercises. Carraher et al. found significant differences in the oral versus written computation

and that the oral procedure was significantly superior to written procedure at the .002 level. However, there was no indication that the situation in which arithmetic problems are embedded has an effect on the number of correct responses obtained.

In South America, Carraher et al. (1987), working with street children in Brazil observed that children who knew before they went to school, how to solve creatively arithmetical problems which they encountered in daily life, for example, at the marketplace, could later in the school, not solve the same problem, that is, not solve them with the methods taught in the arithmetic class. This indicates that the children's spontaneous abilities are downgraded, repressed and forgotten, while the learned ones are not being assimilated.

It has also been suggested that the spatial environment influences the development of spatial relationships. Pallascio et al. (1990) conducted a study to examine the influence of children's spatial environments on their development of spatial skills in a situation focusing on the manipulation of small objects and their two dimensional representations. Their observations suggested that Inuit children and children from an urban environments, differed from each other in their perception and representation of their geometric properties of different objects and in their spatial skills.

Another study conducted by Pallascio et al. (2002) on Inuit students had as its objectives, among others, to (1) understand more fully the number of determinants in the metacognitive processes of Inuit students when they are faced with solving problems related to spatial ideas; and (2) to identify the sociocultural elements that teachers and curriculum developers should consider along with students' interest and motivation when designing curricula and when planning instruction. After analyzing the data collected using learning activities and questionnaires on the students' interests, cognitive and metacognitive aspects of the tasks, Pallascio et al. observed that the students manifested the weakest interest in the most decontextualized activities—that is the activities having the fewest cultural connotations,

whereas the more contextualized activities, which had greater cultural or everyday connotations, drew a more positive response. Not only were the students more interested in the learning activities, their confidence and self-esteem were greatly improved as they could easily relate to the learning activities since they were based on their everyday experience.

The above observations by Pallascio et al. (2002) are at the heart of ethnomathematics pedagogy. Within this pedagogy, cultural relevance is the determining factor for both the learning activities and the classroom instructions. For instructions to be culturally sensitive, content and pedagogy must be culturally congruent. Ethnomathematics pedagogy also subscribes to a constructivist theory that emphasizes situated and contextualized learning. In classrooms governed by constructivist theory, students carry out tasks and solve problems that resemble those in the real world (Glatthorn, 1994). Instead of doing exercises out of context, the student becomes engaged with contextualized problems that allow the learner to connect prior knowledge to new knowledge and transfer new knowledge and understanding to real situations.

The recurrence of research findings which demonstrate the relationship between an individual's cultural background and their ability to construct mathematical concepts suggest that assumptions regarding understanding and application of mathematical knowledge as a result of learning in context may be over simplistic. The above research studies only illuminate how much success students will experience in mathematics education not only in Cameroon but everywhere if their prior learning or "primitive knowing" (Pirie & Kieren, 1991) is used as the starting point for learning school mathematics. By building upon the mathematical knowledge students' bring to school from their everyday experiences in their own culture, teachers can encourage students to: (a) make connections between the mathematics embedded in their culture and school mathematics in a manner that will help formalize the students' informal mathematical knowledge, and (b) learn school mathe-

matics in a more meaningful, relevant way. School "mathematics teaching can be more effective and will yield more equal opportunities, provided it starts from and feeds on the cultural knowledge or cognitive background" of the students (Pinxten, van Dooren, & Soberon, 1994, p. 28).

3.5 Conclusion

Teachers, researchers, mathematicians, and policymakers have all argued about what curricula should be used in classrooms. Although proponents of relevant curricula agree about the importance of contextualized mathematics instructions, they have rarely considered the ways in which foreign and transplanted curricula and mathematics content can or do impede students liking, learning of mathematics and claim of ownership in the development of mathematical knowledge. Yet, to be successful, the constant changes to school curricula call for different kinds of learning approaches and role changes in students and teachers.

While it is generally agreed that mathematics knowledge is needed by all mankind (Bishop, 1988a; D'Ambrosio, 1994; Gerdes, 1997), educating Cameroonians mathematically consists of much more than just teaching them some mathematics. It requires fundamental awareness of the values which underlie mathematics and a recognition of the complexity of educating Cameroonian children about those values. It is not enough to merely teach them mathematics; we need also to educate them *about* mathematics, to educate them *through* mathematics, and to educate them *with* mathematics (Bishop, 1988b). Hence we need to move conceptually from the idea of 'teaching mathematics to all' towards 'a mathematical education of all and for all'.

Mathematics education in Cameroon should be aimed at furthering understanding of mathematics as a social and cultural construct of all. To accomplish this, I belief it is necessary to broaden the status and functions of mathematics in our society to go beyond being seen as a barrier or filter to educational and/or career

aspiration. This will require looking for culture elements, that survived colonialism and that reveal mathematical and other scientific thinking. An ethnomathematics conception to the mathematics education would assist in this task. I see an ethnomathematics approach to mathematics education in Cameroon as responding to the question, "How can the mathematics curriculum and teaching methods be adapted to the needs, backgrounds, interests, and abilities of students?" An ethnomathematics approach will shift the focus away from students' misunderstanding of formal mathematics concepts by assuming that students possess mathematical knowledge acquired from the daily cultural activities they participate in. The focus will be on how to learn about and build upon that indigenous mathematics knowledge. Such an ethnomathematical approach, connecting mathematics and culture, is precisely at the heart of culturally relevant teaching pedagogies. The general empowerment through ethnomathematical knowledge is, I feel, a very important part of the struggle to overcome a colonized mentality.

In this Chapter, I have reviewed the state of formal mathematics education in Cameroon and made the case for the need of a relevant cultural approach. I have argued that an ethnomathematics foundation to the school mathematics curriculum will assist in empowering Cameroonians to emerge from the grip of colonialism that has continued to plague development efforts. Success in such a curriculum will depend on how broad based the curriculum development and implementation process is. I have also argued that such curricular changes have to be systematic and the views of all the curriculum stakeholders seriously considered. In the next Chapter, I outline the methodology employed in assessing the stakeholders' receptiveness to a proposed ethnomathematics curriculum foundation.

Chapter 4

RESEARCH METHODOLOGY

4.1 Introduction

This chapter begins with a brief statement of overview of the study followed by a presentation of the methodology adopted. This is then followed by a description of the design and the precise methods used in the collection and analysis of the data.

4.2 Statement of Research Overview

Formal education in Cameroon has continuously been criticized for failing to prepare the kind of individuals Cameroon dearly needs at the dawn of the 21st century. Critics of the system of education have blamed the school curricula for being inappropriate and unresponsive to the needs of the Cameroonian. Mathematics education has received its own share of the blame for alienating Cameroonians from the very values the country has been trying to inculcate. The poor student performance in school mathematics and the declining level of enrolment of students in mathematics and mathematics related carriers at the secondary school and institutions of higher education are a major concern to the educational authorities in Cameroon. While there has been a general consensus that this problem needs urgent attention, there has been little agreement as to what steps to take exactly to begin to address the problem. A sound understanding of the issues plaguing mathematics education in Cameroon is a necessary first step towards providing some possible solutions. The impetus to this project is framed by the argument that "increasing the relevance of school mathematics to the lives of child-

ren involves more than merely providing 'real-world' contexts for mathematics problems; real-world solutions for these problems must also be considered" (Silver et al., 1995, p. 41).

Providing real-world solutions would require developing alternative curriculum conceptions and pedagogic orientations to mathematics education. And one of the ways Cameroonians can break away from a cycle of inappropriate education is by identifying individual characteristics, practices and behaviours that are valued in the society, analysing them, and according to priority, developing a curriculum that would develop the kind of individuals needed to build a self reliant nation. To do this requires getting all those involved in the education of the child to participate in crucial decision making sessions regarding the curriculum. The role of the teachers and students needs to be emphasized, and most importantly input from the students should be seriously considered since they are the ones who are going to be affected most. One of the methods that certainly lends itself well to such an approach and to this project is that of ethnomathematics. Before developing an ethnomathematics informed curriculum, it will be necessary to understand what effects ethnomathematics will have on the secondary school curriculum.

For reasons of both significance and strategy, the purpose of this study was to make a systematic inquiry into the stakeholders' interests and response to an ethnomathematics curriculum foundation. The precise question that this project is answering is: How receptive are the curriculum stakeholders in Cameroon to an ethnomathematics foundation to the school mathematics curriculum? Knowledge of the stakeholders' interests and response to an ethnomathematics curriculum foundation is crucial if Cameroon is to develop a more appropriate alternative mathematics curriculum for its secondary schools. A cultural foundation of the curriculum is significant since every human society is often identified by its cultural practices and mathematics is a form of cultural knowledge (Bishop, 1988b). It is therefore important to know how a relevant cultural approach to the curriculum can

be developed and implemented, what would need to change and what would be retained in the current school mathematics curriculum. Hence, focusing on the stakeholders' interests and response is a deliberate strategy of working with those who play a major role in curriculum development and implementation process in Cameroon.

4.3 Methodology Used in this Study

The thrust of social science is gathering data that can help us answer questions about various aspects of society and thus enable us to understand society (Bailey, 1982). Hence, knowledge produced by social science is a powerful and effective means to influence decisions regarding people's everyday lives. Whether this knowledge is used for the advantage or disadvantage of the group of people under study depends on who controls the research process (Guba & Lincoln, 1989). Conducting research in a country like Cameroon with an inherited bicultural system of education and a multiplicity of cultural polity requires formulating a research methodology that is not only ethical but politically legitimate – sensitive and responsive to the political, social, and cultural community – and yet can be encompassing so as to allow one to tap into a much deeper understanding of the Cameroonian society and answer questions about various aspects of the (mathematics) society.

Most research in mathematics education until recently have been grounded in cognitive theories that tend to privilege Western epistemologies and methodologies. Hence, when one decides to conduct research on other ways of mathematizing, one is immediately confronted with the problem of choice regarding theoretical, conceptual, epistemological and methodological frameworks. Either one applies an already established framework on Western thought or one labours to assemble a framework that not only legitimizes non-Western epistemologies but empowers those whose voices and ways of knowing have been relegated to the

background. Before presenting the methodology employed in this study, I will briefly review some methodologies used in related studies of ethnomathematics.

There is a growing body of literature on studies related to ethnomathematics. Some of these studies have focused on demonstrating the cultural connections of mathematics knowledge (see for example, Ascher, 1981; Bishop, 1988a; Gerdes, 1988a; Restivo et al., 1993). Others have focused on understanding the social connections (see for example, Carraher et al., 1985, 1987; Frankenstein, 1983; Masingila et al., 1996; Presmeg, 1988) of school mathematics. Still, others have focused on understanding the mathematics present in some given contexts (see for example, Boaler, 1993; Dowling, 1991; Masingila, 1993; Nunes, 1992; Saxe, 1991). It has been suggested (see for example, D'Ambrosio & D'Ambrosio, 1994) that answers to these questions seen as germane to our understanding of the cultural connections of mathematics are better sought through the use of the so-called qualitative research paradigm.

Extensive reviews of literature on mathematics and culture (see for example, Lave, 1988; de Abreu, 1998; Gerdes, 1986, 1991, 1993; Lerman, 1998, 2000, 2001; Nunes et al., 1993; Saxe, 1991; Stigler & Baranes, 1988) show that most research in this area generally follow a more socio-cultural approach using qualitative methods such as ethnography, interview, observation, participatory-inquiry, researcher introspection (Masingila et al., 1996), journal entries (see for example, Powell & López, 1989; Powell & Ramnauth, 1992), and 'talking aloud' in which the researched are encouraged to verbalize whatever ideas come to their head (see for example, Jurdak & Shahin, 1999; Newell & Simon, 1972; Ginsburg, Kossan, Schwartz, & Swanson, 1983). On the other hand, previous studies have tended to use an anthropological-didactic approach to understand the evolution of mathematical ideas (Gay & Cole, 1967) and even to uncover hidden moments of mathematics thought in other cultures or social groups (see for example, Gerdes, 1988b).

Still others have maintained the more traditional paradigm of quantitative methods such as various types of questionnaires, translated intelligence tests, to investigate the relationship between a learner's culture and their ability to learn mathematics (see for example, Saxe, 1991). The positivist research paradigm is losing ground in favor of an interpretative approach (Walker, 1992). This is because positivist research presupposes a structured design in which the hypotheses and techniques are determined *a priori*. Large survey studies and studies that focus on general trends are no longer in vogue, and the new trust is in interpretative case studies. In most of these studies, the aim has often been to make sense of what is going on in the classroom.

In recent years, more and more researchers have advocated the use of a wide variety of research techniques, including both quantitative and qualitative methods, for the best attainment of their research aims. McLeod (1992) proposes that "research on cognitive issues in mathematics education should develop a wide variety of methods" (p. 591). Howe (1988) also points out that we are yet to find any convincing evidence that qualitative and quantitative methodologies are not compatible. Boaler (1999) in her analysis of the data from a 3-year case study of two schools suggests that our understanding of mathematics learning in the classroom "cannot be validly portrayed without the long-term focus characterized by ethnographic accounts or the multiplicity of perspectives captured by a range of qualitative and quantitative research methods" (p. 279). Evans (1994) used both a qualitative and quantitative methodology in his study on adults' mathematics anxiety and he too, suggests that we should make use of the strength of both paradigms as long as they provide the most effective ways to investigate the questions under study.

A number of researchers (Closs, 1986; Gerdes, 1993) have recommended qualitative research methods as promising and appropriate for the study of mathematics and culture. Closs (1986) suggested that studies on the history of mathematics must take the "form in which an almost total reliance on the historical approach is

supplemented or replaced by drawing on the resources and methodologies of other disciplines such as anthropology, archaeology and linguistics" (p. 2). Likewise, Gerdes (1993) suggested that a qualitative approach such as 'cultural conscientialization' which involves the replication of the production techniques of some cultural objects and then studying the mathematics embedded in them, is another potential method for studies involving mathematics and culture. Gerdes and his colleagues in Mozambique used this approach to uncover hidden mathematics in traditional geometric objects like baskets, mats, fishtraps and even houses.

Similarly, after extensive reviews of research on mathematics and culture, Boaler (1993) proposes that besides the traditional method of using questionnaires and the studying of cultural artifacts and practices, "additional measures such as open-ended and semi-structured interviews and observation of behaviour must be included if richer and more accurate references must be made" (p. 348). In order to develop a picture of the classroom situation, which made explicit the patterns, and events which comprised the learning environment, she used a combination of observations, interviews and material analyses. In addition, she also suggests that, current research in everyday mathematics, mathematics learning in context and socio-mathematics are some other promising research approaches.

To summarize, there is no single encompassing method that purports to be the 'best' in research involving mathematics and culture. The best combination of methods is that which can best help us effectively investigate issues at hand. The choice of the methodology is entirely dependent on the nature of the research design, namely the size of the sample, and the aims of the research. The foregoing review suggests that small sample sizes and in-depth studies call for qualitative methods such as interview, questionnaire, observation, document analysis, and researcher introspection.

When it comes to analysing the data collected, many studies have used a variety of techniques. Smaller in-depth studies or studies with smaller sample-size

have favoured the use of categorization (see for example, Manouchehri & Goodman, 2000) while others have tended to identify facets as a means of understanding the phenomenon (see for example, Matthews, 2003). These categories are sometimes predetermined while others emerge in the course of the research or pre-analysis of the data. Still, others have used an inductive approach to analyze the data by looking for concepts and processes involved in the mathematics practice in given contexts (see for example, Masingila et al., 1996). Still yet, others have looked at the link to affective or cognitive theory and in some cases philosophical underpinnings to guide their analysis. For example, in order to understand how teachers attempted to incorporate a 3-component model of culturally relevant teaching into their mathematics instructions, Matthews (2003) identified four facets or complexities in his analysis collected through observations, interviews and group meetings. These are (i) building empowering relationships, (ii) building on culture and fostering critical thinking formally, (iii) building on cultural knowledge and fostering critical thinking informally, and (iv) building to cultural knowledge. It is interesting to note that the first facet or complexity focuses on empowerment while the other three focus on culture and knowledge acquisition, thus suggesting an emphasis on learners' cultural background as germane to success in culturally relevant teaching.

Similarly, in analyzing the data collected from an initial interview conducted to profile the elements that seemed to have greatly influenced the teachers' use of a newly prescribed mathematics textbook, Manouchehri and Goodman (2000) used a thematic approach by categorizing their data using key concepts and occurring themes. These themes then guided their classroom observations and their reconstruction of categories of the teachers' actions during final analysis. These themes or "relationships are often depicted in diagrams, such as grids or other structured boxes, outline- or tree-shaped taxonomies, ... or anything else the researcher can invent" (Tesch, 1990, p. 82).

Other studies that have used categorization in analysing the data collected have adopted already established philosophical orientations or conceptual categories. This may partly be because most of these studies have been anthropological in nature, making use of "pre-existing categories schemes to organize and analyze data" (Merriam, 2001, p. 156). Examples are studies conducted on attempting to unveil cultural moments of mathematical thoughts (see for example, Ascher, 1981; Gerdes, 1986, 1988a, 1988b) or mathematical concepts embedded in cultural practices (Boaler, 1993, Masingila, 1995; Masingila et al. 1996). Most of these studies have in one way or the other used categories established from six fundamental activities by Bishop (1988a) as mathematical and common to every world culture. These categories are: counting, locating, measuring, designing, playing and explaining.

Discernible from the above studies is the idea that constructing a suitable set of categories for the data might be a good way to analyse the variety of data obtained. However, the categories need to be grounded or made to emerge as one goes through the research and data. This is because cultures vary and with cultural studies such as these involving mathematics, what is expressed verbally may be different from what is actually observed in a given cultural context. This study was driven by the belief that successful curriculum change requires an understanding of the stakeholders' interest in reform and with the assumption that stakeholders would hold to different ideologies regarding education in general and mathematics education in particular (curriculum content, purpose and subject areas for curriculum development). From the above review I opted for a qualitative (smaller in-depth research) methodology as the most appropriate approach to inquire into the stakeholders' receptiveness to an ethnomathematics curriculum foundation. The decision to use a qualitative methodology was influenced by the composition of the stakeholders which comprised students, teachers, pedagogic personnel, and university faculty. This decision was further informed by Evans' (1994)

pronouncements that "the qualitative case study approach is useful when we wish to explore the richness, coherence ... and process of development of a limited number of cases" (p. 326). Hence, considering the limitation of time and available resources, the methodology used in this study is similar to that employed by Masingila (1993) but sanctioned by the Kantian framework which employs categorical ethical principles by treating participants as ends in themselves rather than as means (Howe & Moses, 1999). The qualitative methods used in this study derived from the above review of methods used in related studies comprised questionnaire, semi-structured interviews, participant observation, and researcher introspection. Based on the thesis problem, the research was conducted in three steps. Step one was the administration of the questionnaire. Step two involved the development and observing the teaching of an ethnomathematics unit. Step three was a combination of semi-structured interviews and questionnaire.

Semi-structured interviews were conducted with 4 secondary mathematics teachers (2 from public secondary school and 2 from private secondary school), 1 pedagogic adviser, and 1 university faculty (teacher educator). The interviews were intended to supplement information collected using the questionnaire.

4.4 The Research Site

The study was conducted in Cameroon, a country roughly the size of California and located in central Africa. The study involved two schools located in the North West province, one of the predominantly English speaking parts of Cameroon (the other being the South West Province), having been colonised by the British after the World War I. Hence the system of education in these provinces is patterned after the British. Over the years, government's attempt to bring education and administration closer to the people has led to the creation of local governments at the provincial level such as the Delegation of Education, the Pedagogic Inspectorates for primary and nursery education, and for secondary education.

These provincial government offices oversee the smooth functioning of the various schools (both public and private) and educational programmes within the province and report to the minister of education. The decision to limit the research to two schools was a pragmatic one. The two schools that participated in the study were determined only after permission to conduct the research had been granted by the respective educational authorities in Cameroon.

Being able to function in social situations such as educational contexts requires some level of intimacy with complex social and cultural perspectives as well as a range of personal language resources. Being an insider (a native of Cameroon) provided me with the level of intimacy and cultural perspective required in this kind of research. I was also aware of Miller's (1995) cautions about the subjectivity and objectivity of the researcher in interviews. Miller (1995) warns that,

> Familiarity with a situation may lead to some loss of objectivity on the part of a researcher who may be unable to stand back from the situation and to see it from a perspective of distance. Too many aspects of a situation may be taken for granted and it may be difficult to ask naïve questions about situations which are already familiar. On the other hand, Hockey (1993) suggests that an insider may have a rapport with informants which may be lacking in a stranger. There may be certain linguistic and cultural familiarity which enables the researcher to understand the situation and interact more readily. (p. 30)

Being a native of Cameroon facilitated entry into the research site and establishing an immediate rapport with the participants. As a former teacher, familiarity with the educational system and the culture of teaching was an advantage. Taking on the role of semi-insider/researcher helped maximize objectivity and minimize subjectivity. Gans (1982) captures this role as one "who participates in a social situation but is personally only partially involved, so that he can function as a researcher" (p. 54). I was very aware that to conduct research in a country like Cameroon where hierarchy is well-regarded, the very success of the

whole project depended on respecting this hierarchical structure of the entire system when seeking for permission and even later when conducting the study.

After arriving at the research site, I requested a meeting with the provincial delegate for education. The provincial delegate for education represents the minister of education at the provincial level. It is through his/her office that permission is requested to conduct research in any school in the province. During the meeting with the provincial delegate, I presented him with a written letter of information describing the purpose of the study and the role the schools play. Written permission was then requested and granted (see Appendix A for sample request for permission forms). Shortly after that, I met separately with the provincial pedagogic adviser for mathematics and the university mathematics (teacher educator) to seek their respective written consents to participate in the study. As with the provincial delegate, consent from the pedagogic adviser and university mathematics (teacher educator) were secured through oral and written solicitations. The study was initially intended to include two university instructors (teacher educators) versed in the secondary school mathematics curriculum. However, only one teacher educator was available to participate. Hence only one teacher educator participated in the study. Although only one teacher educator participated in the study, the information collected from him was significant thanks to his years of experience teaching secondary school mathematics, undergraduate mathematics and secondary mathematics teacher education courses.

4.5 The Schools

Having secured written permission to conduct the study and obtained written consent from the pedagogic adviser and teacher educator, I decided which two secondary schools would be part of the study. Poor communication due to poor conditions of the roads and telephone network system were major determinants in deciding on which schools to include in the study. The two schools chosen for the

study were Cameroon College of Arts, Science and Technology (CCAST) Bambili and City College of Commerce (CCC) Mankon. What made these two schools interesting for this study was the contrast in their proportion of formally trained teachers and the variance in their instructional approaches to school improvement, school organization, and professional cultures. These two schools apart from being interesting for this study, were also chosen because of: (1) their proximity to each other (25km apart). This was a pragmatic decision imposed by the poor road infrastructure in the country and because the researcher did not have a car and had to rely on public transportation to commute between the schools; (2) one was public (CCAST) and the other private (CCC) – the two main providers of formal education; and (3) CCAST represented a typical public school in the country with all the teachers being formally trained while CCC represented a typical private school with a majority of the teaching corps not formally trained. I visited the schools and met separately with the principals in their respective schools. Written consent and permission to conduct the study in these schools was sought from the principal of each school independently. Once the respective principals had granted permission (see Appendix A for sample request for permission forms), I scheduled a meeting with all the mathematics teachers of each school with the respective principals facilitating this process. The purpose of the research study and the requirements for voluntarily participating in the study were outlined in both written and oral form. In the public school (CCAST Bambili) 5 teachers teaching Form[6] 2 mathematics to 13 and 14 year-olds volunteered to participate in the study. Of the five teachers, three of

[6] Junior secondary school in Cameroon spans 5 years and this is preceded by 7 years of elementary education. Form 2 is the second year of junior secondary school for students aged 13-14 years old. At the end of the fifth year (Form 5) students following the Anglo-Saxon system of education write the General Certificate of Education (Ordinary Level) examination. Success in at least 4 papers is required for admission to the senior secondary (high school) where after 2 years, students can sit for the Advanced Level of the General Certificate of Education (GCE A/L) examination.

them taught mathematics to separate streams of Form 2 at the same time (07:00-07:50) each day while the other two teachers had their sessions around midday (11:40-12:30 & 12:30-13:20). Since the study needed just two teachers, the two teachers with classes around midday were selected while the two teachers selected in the private school (CCC Mankon), where there were only five mathematics teachers and three of them volunteered, were those with classes in the morning (07:00-08:40). This purposeful selection allowed the researcher the ability to make observations in both the private school (07:00-08:40) and public school (11:40-13:20) the same day. Written consent to participate in the study was then granted by the four teachers separately (see Appendix A for sample copy).

CCAST Bambili

CCAST Bambili is a government high school located in Bambili, a small rural town of under 25,000 inhabitants. It is just 20km from Bamenda, the main city and provincial capital of the North West province. CCAST is a mixed school with a student population of over 3200 of which 54% are males and 46% are females. It is a day/boarding school and the student hostels are coed. However, the majority of the students are day students living in privately owned rented apartments outside the school. This school carries the perception of being one of the best schools in West Cameroon and this is not difficult to see. This is because (1) it is the oldest public educational institution in West Cameroon, (2) it graduates relatively large numbers of students each year, (3) many graduates from this school have moved on to occupy positions of responsibility in the government, (4) its junior secondary section is often used for student teacher practicum, and (5) its proximity to the school of education (Ecole Normale Supérieure Bambili) places it at a vantage point of luring the best teacher graduates from the school of education. Over 90% of the teachers in CCAST Bambili are formally trained as teachers while less than 10% have a university degree in a specific subject like mathematics, language arts, social studies, etc.

CCC Mankon

CCC Mankon is a private high school located in the heart of Bamenda, an urban city of more than 800,000 inhabitants. It is the provincial capital and the main commercial city hosting more than 80% of the banking sector. CCC is a mixed, day school with an average student population of 2800 of which 49% are males and 51% are females. CCC Mankon, like many private secondary schools in the country is reputed for admitting students who have been denied admission into other government secondary schools because of low academic achievement or who otherwise would not pursue secondary education for one reason or the other. Hence students in this school are usually considered as low underachievers compared with their counterparts of public educational institutions. Unlike CCAST Bambili, CCC receives a very limited number of student teachers for practicum purposes. Only 30% of teachers in CCC are formally trained, 36% have a university education and 34% are high school graduates.

4.6 The Stakeholders

Participation in this study was voluntary. The participants in the study comprised 4 secondary mathematics teachers, one university faculty, one pedagogic adviser and 40 students from each of the two schools. Hence a total of 80 students participated in the research. Parents were not included in the research because they are not considered as stakeholders within the Cameroon education community and so do not play any role in curriculum change. This is a mindset inherited from the colonial days when the colonial educators took all major decisions regarding the curriculum. And since this study was to investigate those who play a role in effecting curriculum change, the parents were thus excluded. All the participants were chosen only after permission to conduct the study had been granted by the provincial delegate for education and the principals of the two schools. Students in private schools follow the same syllabus and write the same examinations as those

in government or mission schools. There is tremendous pressure on private school teachers to make sure that their students in examination classes are adequately prepared for national examinations. Most teachers (95%) in these private schools do not have any pedagogic training. A majority of the teachers are high school graduates (GCE 'A' Level holders) while less than half have a university degree. Most of these teachers turn to teaching as a last resort.

4.6.1 The Pedagogic Adviser

Cameroon is administratively divided into ten provinces. In each province, there is one pedagogic adviser per school subject or subject area. This personnel, usually appointed by the Minister of national education, is often someone who had been a secondary school teacher for a reasonable length of time – one who is deemed as having garnered extensive relevant pedagogic skills to advise other teachers, especially novice teachers. These individuals work out of the pedagogic department of the provincial delegation of education. The pedagogic adviser is in charge of co-ordinating the teaching of mathematics in the province in general. S/he is also responsible for looking into the problems teachers face in the classroom and providing supervisory support to the teaching of mathematics in the province. S/he ensures that teachers' pedagogic skills are up-to-date and this is usually done through regular visitations to the schools and by organizing pedagogic workshops and seminars. The pedagogic adviser who participated in this study was one who also happened to be the coordinator of the provincial Teachers' Resource Centre (TRC). Hence he had the dual role of adviser and coordinator of the TRC. His duties as the coordinator of the centre, which at times overlap with those of the pedagogic adviser, include coordinating the work of all the other advisers (primary and nursery, secondary, technical and commercial education) within the TRC. The TRC as aptly named is charged with producing resources for teachers within the entire province and enabling teachers to come in and produce resources for themselves. As

the coordinator of the centre, it is his duty to coordinate the production of teachers' resources, organize workshops and seminars and this means going to the field to see what the teachers need, returning to the centre to encourage the other subject area advisers to respond to those needs in the field. It is his duty to facilitate the movement of advisers to the field, reporting to hierarchy what is needed in terms of resources, and being able to follow-up to see that those resources are provided to the advisers.

4.6.2 The University Faculty

Since gaining independence in 1960, there have been two secondary school teacher-training institutions in Cameroon – one for training teachers for technical and commercial secondary education (Ecole Normale Supérieure d'Enseignement Technique – ENSET) and the other for training teachers for secondary grammar or general education (Ecole Normale Supérieure – ENS). The one responsible for training secondary grammar teachers is being run under the auspice of the University of Yaounde I with campuses in Yaounde and Bambili. The Bambili campus is solely responsible for training teachers to teach in Anglo-Saxon schools while that in Yaounde is principally for Francophone teachers. The university faculty who participated in this study teaches at the Bambili campus. He too, a former graduate of ENS Bambili had been teaching mathematics in the secondary school for close to 30 years. Now as a full-time lecturer, he teaches mathematics education courses for secondary school student-teachers. During his tenure as a secondary school mathematics teacher, he participated in numerous curriculum workshops and seminars, worked with curriculum experts from abroad on the school mathematics curriculum for Anglo-Saxon schools in Cameroon and also taught part-time at ENS Bambili.

4.6.3 The Teachers

Teachers are important agents of change. In the context of curriculum change, the teachers' understanding of the connection between mathematics and culture and of teaching in context can be quite pivotal in the development and implementation of culturally relevant mathematics curriculum. The 4 teachers who participated in this study all taught 'Form 2' mathematics to 13 and 14 year-olds. As stated above, the teachers were selected based on their daily schedules so that it was possible for the researcher to observe lessons in both schools the same day. The four teachers varied in their educational background and years of teaching experience. Of the four teachers who participated in the study, two were teaching in CCAST Bambili, a public high school while two were teaching in CCC Mankon, a private high school. Both teachers in CCAST were graduates of the teacher training college (ENS Bambili) while the two teachers in CCC were holders of a bachelor's degree in mathematics from neighbouring Nigeria. One of the teachers in the private school had been teaching for 22 years while the other had been teaching for 10 years. In CCAST Bambili, one of the teachers had been teaching for 15 years while the other had been in the teaching corps for 12 years. Both teachers in CCC were males while one teacher in CCAST was female. In CCAST, 5 out of 16 teachers are females (31.25%) while all the teachers in CCC (5) were males.

4.6.4 The Students

Students in the public school system are selected from the top 30% of those who pass the Cameroon elementary school Common Entrance examination. Most of the remaining 70% of students enroll in private and mission schools. As a consequence, enrolments in these private schools are sometimes enormous. A typical grade level in these schools has between 200 and 300 students compared to an average of only 180 per grade level in most public schools (Johnson, 2000). Because generalizability was not an aim of this study, the decision to include 40 students

from each school (total of 80 students) in the project was a logistic and pragmatic one. I will however argue that this number of students was reasonable and the data collected from this size of the student participants was rich and considerable.

For the students who participated in this study, consent was obtained through written solicitation. Students who could not grant consent had to get the consent form signed by a parent or guardian (see Appendix for copy of Letter of Information and Consent forms). All the 80 students who participated in the study were in Form 2 and were day (non-boarding) students living in rented apartments outside the school environment. Each of the Forms (Grades) is divided into several streams. The grouping of students into streams is not based on ability but dictated by the number of students who are admitted to that particular Form. In CCAST Bambili, Forms 1 to 3 each is divided into fives streams labeled A, B, C, D, E and Forms 4 & 5 are each divided into four streams labeled A, B, C, and D. This is because the student population decreases as we move higher, a decrease attributable to poor student performance and student dropout. Hence students who participated in the study in CCAST Bambili were in two of the streams in Form 2. Each stream in Form 2 had an average student population of 65 thus totaling more than 320 students in Form 2. The student questionnaire was administered to 40 students (20 from Form 2A and 20 from Form 2D) randomly selected from all the students in Forms 2A and 2D who had consented to participate in the study. The group of 20 students from Form 2A was designated the ethnomathematics group and was taught the ethnomathematics unit while the group of 20 students from Form 2D was designated the non-ethnomathematics group and was taught the regular mathematics unit. Forms 2A and 2D were so selected because these streams were being taught by the two mathematics teachers who consented to participate in the study.

In CCC Mankon, all the Forms were also streamed with Forms 1 to 3 each divided into four streams A, B, C, and D, and Forms 4 and 5 each divided into 3 streams A, B, and C. Like in CCAST Bambili, the student population also decreased

as we moved higher with Form 1 having the largest number of students and Form 5 the lowest. In Form 2, there were a total of 250 students divided into four streams of 63, 63, 62, and 62. Just like in CCAST Bambili, the student questionnaire was administered to 40 students (20 from Form 2B and 20 from Form 2C) randomly selected from all the students in Forms 2B and 2C who had consented to participate in the study. The group of 20 students from Form 2B was designated the ethnomathematics group and was taught the ethnomathematics unit while the group of 20 students from Form 2C was designated the non-ethnomathematics group and was taught the regular mathematics unit. Forms 2B and 2C were so selected because these streams were being taught by the two mathematics teachers who consented to participate in the study.

4.7 Data Collection

Having secured the necessary permission and statements of consent from all the participants, it was now time for data collection. Before the study actually began, a pilot study was conducted on the questionnaires and semi-structured interview. The aim of the pilot study was to clarify any ambiguities that may exist in the wording or sources of misinterpretation of the questions. The comments and suggestions from the pilot group of mathematics students, student-teachers, and teachers were used to revise the questionnaires and the interview protocol which became what is found in the Appendix A. The semi-structured interview protocol was piloted with 2 mathematics student-teachers and 2 secondary mathematics teachers (one from a public and one from a private secondary school that did not participate in the study). This pilot interview was used to evaluate the questions and to refine the interview and analysis techniques.

Data collection for this study occurred in three stages and this began after the permission and consent had been secured from all the authorities and participants.

4.7.1 Step One: Questionnaires

All the questionnaires in step one were administered during the first week of the study. In step one, my aim was to establish an information base of the stakeholders on key issues to be further explored in the research. I recognized that this initial questionnaire might not provide in-depth information but at the very least, provide a sense of the stakeholders' response regarding an ethnomathematics curriculum foundation. Kerlinger (1986) maintains that information gleaned from questionnaires of this kind do not go deep enough. The scope of the information is "usually emphasized at the expense of depth" (p. 387). In view of this limitation, I structured the questionnaire with a variety of question types, including open-ended questions, structured questions with 'yes-no', five-point scale, 'ranking in order of importance', and 'choosing as many options described from a large selection'. Because the stakeholders comprised four groups of participants (students, teachers, pedagogic personnel, teacher educator), the questionnaires varied slightly in content and purpose for each stakeholder. For the students, the questionnaire was to establish a knowledge base of the students on their views on mathematics. For the teachers, the purpose of the questionnaire was to determine where the teacher stood regarding an ethnomathematics approach to the secondary school mathematics curriculum. The pedagogic inspector's questionnaire, while almost similar in focus to that of the teachers, had the added focus of role determination in curriculum reform. And lastly, the university faculty's questionnaire was also similar to the teachers' with the added focus of a teacher educator and curriculum reform participant. Details on the administration of the individual questionnaires are described below.

Student Questionnaire: At the start of the data collection process, the researcher administered a questionnaire to the 40 students in the selected stream of Form 2 in each school. Hence a total of 80 students responded to the questionnaire. Each student who completed the questionnaire was given a randomly generated alpha-

numeric code, which could be used later on for verbatim quotation. This questionnaire was administered in the students' regular classroom during one of the mathematics period. The questionnaire contained 15 items of which 8 were open-ended questions. Of the remaining 7 questions, 4 were of the Likert-scale type with 5-point scales, 2 were of the rank type, and 1 of the 'Yes-No' type. The students were given one hour to complete the questionnaire. I went through the questionnaire with the students reading out each question and explaining what was required of each (see Appendix A for a sample). In some cases I had to re-read the question and explain what the question was seeking. Some questions were not responded to during this time. This was expected since there were questions which the students could answer effectively only at Step three of the data collection. The researcher collected the questionnaires once the students were done.

Teacher Questionnaire: The researcher administered the teacher questionnaire at the start of the data collection process, which was after the teacher participants had been determined and their written consent granted. This took place at the teachers' respective schools and before the ethnomathematics unit had been prepared with the teachers. The decision to administer this questionnaire at this time was to ensure that the teachers' response to the questions was not influenced by the ideas and notes found in the ethnomathematics unit. Each teacher was given a randomly generated alphanumeric code, which could be used later on for verbatim quotation. The teacher questionnaire contained 26 items of which 14 were open-ended questions and the remaining 12 questions were multiple-choice of the Likert-scale type with 5-point scales (see Appendix A for a sample). The teachers were given sufficient time to go through the questionnaire. Teachers in each school responded to the questionnaire the same day. This took place when both teachers had more than one hour of free time in school. This ensured that the teachers did not influence each other's responses to the questionnaire items. The questionnaires were then collected once the teachers were through with them. The questionnaires from

the two teachers in each school were all analysed for this study. Hence a total of 4 teacher questionnaires were analysed.

Teacher Educator and Pedagogic Adviser Questionnaire: The questionnaires for the pedagogic adviser and the university mathematics (teacher educator) were very similar to that of the teachers. The pedagogic adviser questionnaire contained 28 questions of which 15 were open-ended questions and 13 were multiple-choice questions of the Likert-scale type with 5-point scales (see Appendix A for a sample). The university faculty questionnaire contained 27 questions of which 14 were open-ended questions and 13 were multiple-choice of the Likert-scale type with 5-point scales (see Appendix A for a sample). The teacher educator completed the questionnaire during office hours at ENS Bambili while the pedagogic adviser completed his during office hours at the Pedagogic Centre. The researcher administered the questionnaire on separate days because of logistic reasons and also because it was not necessary that both be administered the same day since the two participants didn't work together. Each respondent took about 1½ hours to complete the questionnaire. The researcher collected the questionnaires once they were done.

4.7.2 Step Two: The Ethnomathematics Unit

The second stage of the research involved developing an ethnomathematics unit (see Appendix B for sample Cameroonian games and the mathematics in them which were used in the unit) for Form 2. This occurred after the questionnaires had been administered and I took about a month to develop the unit plan. The researcher developed this unit with some input from the teachers, pedagogic adviser and university faculty. The unit was intended to last 4 weeks but lasted 6 weeks. This was because classes were disrupted for more than a week during which time schools

participated in Youth Week[7] activities. Two teachers (one in each school) taught the ethnomathematics unit to one stream of Form 2 (2A in CCAST and 2B in CCC). The other two teachers (one in each school) taught the regular mathematics unit (covering the same concepts as the ethnomathematics unit) to one stream of Form 2 (2B in CCAST and 2C in CCC).

In developing the ethnomathematics unit I made use of local resources by including cultural games (game of pebbles, game of sevens, game of whodunit, and game of the diamonds) and the mathematics embedded in them (see Appendix B). Criteria for selecting illustrations of mathematical concepts to be incorporated and analyzed included that the illustrations: (a) contain some identifiable mathematical activities according to Bishop's (1988) six fundamental activities: "counting, locating, measuring, designing, playing and explaining" (pp. 182-183), (b) be rich in cultural knowledge such as indigenous mathematics knowledge, (c) contain mathematical objects such as geometric shapes, mathematical implements, and (d) mathematical objects of inquiry.

Since I was looking for the reaction to the notion of ethnomathematics, the aim of the unit was to raise the awareness in the students. The unit was not assessing the teaching of ethnomathematics. The unit was appropriate because I knew about the activities and could identify the mathematical processes embedded in them. The unit was also appropriate because I played the activities as a youth. The activities listed in appendix B are intended for illustrative purposes only. These activities were part of the ethnomathematics unit that was developed to cover the concepts the students were supposed to learn during that period. The teachers were given ample flexibility on how to incorporate the material into their teaching but making sure

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[7] Youth Week is a public holiday in Cameroon. Festivities for this holiday range from presentations to intramural activities such as singing, dancing and playing competitions to educational programmes, and usually last a week culminating with the Youth Day (February 11) celebration involving all educational institutions in the country.

that the mathematics embedded in the activities was explored and discussed with the students. The teachers sometimes used group investigations to get the students develop an explanation for how some of the games were played. Students were then asked to present their findings from which the lesson proceeded.

I realized that probing the teachers' interest and response to an ethno-mathematics curriculum foundation would be incomplete without an observation of how the teachers were incorporating relevant cultural aspects into their mathematics instructions. This is because most of what a teacher knows or believes may be tacit, not easily accessible to the researcher and may be revealed only in the teacher's actions (Pajares, 1992; Ross, Cornett & McCutcheon, 1992). As Merriam contends, "observations are also conducted to triangulate emerging findings; that is, they are used in conjunction with interviewing and document analysis to substantiate the findings" (Merriam, 2001, p. 96). Hence an observation of how this is carried out in the classroom and the interest and response from the students was therefore necessary. Observations were guided by broad questions that looked at:

- How teachers build on students' cultural knowledge and informal experiences in teaching mathematics,
- How teachers fostered critical mathematical thinking and used a historical approach in teaching mathematics,
- How teachers incorporate empowerment orientations toward culture and experience in the teaching of mathematics, and
- How often teachers used a historical approach or a historical dimension in the teaching of mathematics.

The teachers were observed three times each week until the ethnomathematics unit had been completed which lasted 6 weeks. A total of 12 observations with each teacher were recorded. This is because there were no observations during the 5th and 6th week as classes were interrupted as students rehearsed for the national

Youth Week festivities. Each mathematics lesson lasted 50 minutes. These observations were tape-recorded using a mini pocket digital recorder and a laptop computer. In addition to the observations, I also had numerous informal discussions before and after class with the teachers, and these discussions provided information that I followed up in the semi-structured interview at the end of the ethno-mathematics unit. I carried my mini pocket digital recorder with me at all times and on several occasions when informal discussions were yielding particular useful insights, I asked whether the conversations could be recorded. Permission was always given readily when sought. Data were collected inside and outside class-rooms during the teaching of the ethnomathematics unit. During the observations, I regularly moved around the classroom, observing students' work more closely and occasionally talked to students and the teacher. I had no involvement in the actual teaching of the unit beside developing the unit with the teachers and preparing some teaching aids. Questionnaires, interviews and observations were my primary data sources while various mathematical, curriculum and archival documents provided additional useful data. Data on the students' performances was also collected before and after the ethnomathematics unit.

4.7.3 Step Three: Questionnaires and Interviews

This last stage of the research, which lasted two weeks, occurred shortly after the ethnomathematics unit had been taught. A questionnaire was administered to the students while semi-structured interviews were conducted with the rest of the participants.

Students: The questionnaire administered to the students at the beginning was administered again to the same students in an attempt to understand what effects, if any, the ethnomathematics unit might have had on the students learning of mathematics. It was hoped that students would be able to respond to all the questions this time after having attended the ethnomathematics lessons. The

questionnaire was administered exactly as the first time by the researcher and the completed questionnaires were collected once the students were done.

Teachers, Pedagogic Adviser and Teacher Educator: I recognized that eliciting the stakeholders' interest and response is not an easy task. Some aspects of the stakeholders' response to the ethnomathematics curriculum foundation could not be readily represented by overt propositions made on the questionnaire by each stakeholder. These aspects included experiences, values, emotions, and concerns, all of which were both personal and professional (Carter, 1993; Johnston, 1990). Analysis of the data collected in step one revealed some general information about where each participant stood regarding an ethnomathematics curriculum foundation. To further understand the stakeholders' interests in this proposed curriculum foundation, a semi-structured interview was conducted with each teacher, pedagogic adviser, and university faculty after the completion of the ethnomathematics unit. The semi-structured interview format was chosen because it allowed the interviewer (researcher) to lead the participants to focused and systematic inquiry on proposed topics while allowing the participants some freedom and flexibility in expressing their views and feelings in issues they feel are important to mathematics education in Cameroon. The interview questions were designed to collect data on the stakeholders (excluding the students this time) in six key areas explored in the questionnaire: (1) nature of mathematics, (2) uses of mathematics, (3) mathematics and culture, (4) curriculum reform, (5) mathematics curriculum, and (6) importance of formal education. This was to ensure triangulation in the data as questions posed in the questionnaire were reposed or rephrased in the course of the interviews and the respondents given another opportunity to respond extensively. The teacher interviews took place at their respective schools and interviews in each school were conducted the same day with each lasting between one and two hours. Each teacher interview usually started off with me seeking the teacher's impressions on the just completed ethnomathematics unit. Then I posed questions on the above six areas

and used probing to elicit their interests and response on the possibility of an ethnomathematics curriculum. Other questions posed included: (a) What they valued most about an ethnomathematics curriculum foundation, (b) What they valued least, and (c) What concerns they had for such a curriculum foundation to be adopted in Cameroon. Probing was used to elicit additional information regarding each participant's interests and response to an ethnomathematics curriculum foundation. In the interviews, other teacher characteristics such as years of teaching experience, type of certification, the number of university mathematics courses completed, membership in professional organizations and attendance at mathematics conferences, seminars and workshops were also collected. The interviews with the pedagogic adviser and university faculty took place during office hours at their respective working locations. Similar, to the teachers, the interviews with the pedagogic adviser and university faculty explored the above named six key areas. Each interview session was audiotaped and later analysed. The interviews were transcribed by the researcher for analysis.

Although interviews and questionnaire were the heart of the data collection, documents and archival records were collected to provide an alternative perspective on the research question. Marshall and Rossman (1989) argue that the unobtrusive nature of document and archival record collection provides a rich data source without disrupting the research site. The documents collected and examined for this study were the mathematics text and scheme of work for Form 2.

4.8 Data Analysis

This study was driven by the idea that successful curriculum change requires a deep understanding of the stakeholders' interest in systemic reform and with the assumption that stakeholders would have different ideologies regarding education in general and mathematics education in particular (curriculum content, purpose and subject areas for curriculum development). All the research data was analysed

through a process of inductive data analysis by allowing for common themes, patterns, frequently repeated expressions to emerge.

Padilla's (1991) concept modelling methodology was used as a strategy for organizing and displaying the data. According to Padilla, one way to explain a situation is to identify various assumptions contained in the data and organize them into a coherent whole. In the concept modelling method, assertions contained in the data become fundamental elements for analysis. First, I created a matrix (see Table 6.1) in which to display responses to the six main areas explored in the interviews and questionnaires. Next, I reduced long statements from interview transcripts, questionnaires and excerpts from documents to short paraphrases, and entered these data into appropriate cells of the matrix. I then observed how the data arrayed across the various stakeholders, and then highlighted areas of convergence and divergence among six main areas. The areas of convergence and divergence were used to assess the stakeholders' receptiveness to an ethnomathematics curriculum foundation. This receptiveness was displayed in terms of the stakeholders' levels of interests and concerns in an ethnomathematics curriculum.

4.9 Validity and Reliability of Data Collection and Analysis

Since the data collection in this study was qualitative, Lincoln and Guba (1985) suggest using the term 'trustworthiness' as a more suitable and equivalent term of validity and reliability for the quantitative data. According to them, "'trustworthiness' includes four main criteria: 'truth value', applicability, consistency and neutrality. In other words, it is imperative to establish the 'creditability', 'transferability', 'dependability' and 'confirmability' of the study, which is 'the naturalist's equivalent to the conventional terms "internal validity", "external validity", "reliability" and "objectivity" (Lincoln & Guba, 1985, p. 300). Thus, I attempted to establish the trustworthiness of my data by adopting some of the techniques suggested by Lincoln and Guba.

Firstly, by using the interview to pose similar questions featured in the questionnaire, but this time rephrased, I was able to clarify with the respondent as well as validate the data collected in the questionnaire. This cross-validation indirectly served to enhance the trustworthiness of the data collected by questionnaire.

Secondly, since the majority of the data was collected outside the classroom setting, it is possible that some of what was espoused in the questionnaires and interview differed with what I observed during the teaching of the ethnomathematics unit. In such instances, I replayed segments of the tape-recording done in the classroom and then used follow-up to gain clarity of the respondent's (teacher) responses. This provided some level of trustworthiness in the data collected and also in the analysis that followed.

Thirdly, I was fully aware that as the stakeholders communicated their responses to the ethnomathematics unit to me, I then had to interpret them in terms of statements indicating receptiveness to an ethnomathematics curriculum foundation. I acknowledge the possibility of using researcher introspection to interpret some responses. To ensure that this interpretation did not influence the conclusions drawn from the data, I grounded my interpretations in the data by developing two subcategories to classify the stakeholders' statements of response to the ethnomathematics curriculum foundation in terms of:

- level of interests towards an ethnomathematics curriculum, and
- level of concern towards an ethnomathematics curriculum.

In addition, I tried to interpret the responses holistically and always looked for confirmation of meaning by taking into account their responses to similar questions on the questionnaire and the interview. This provided another level of triangulation in the data.

4.10 Conclusion

To conclude, even though I have justified my choice of the methods used in this study, I acknowledged that there may still be problems and limitations that I have to bear in mind when I analyze my data and report the findings in the next chapters.

Chapter 5

PRESENTATION OF FINDINGS

This chapter presents the data collected on the participants' receptiveness (interest and response) to an ethnomathematical foundation to the secondary school mathematics curriculum.

5.1 Introduction

The purpose of this project was to examine the stakeholders' (students, teachers, pedagogic advisers, and university faculty) interests and response towards a proposed ethnomathematical foundation to the school mathematics curriculum in Cameroon. The main research question as stated in Chapter one is: **How receptive are the curriculum stakeholders in Cameroon to a proposed ethnomathematics curriculum foundation?** To measure and understand this receptiveness, various methods of data collection were employed. These were: participant observation, interviewing, and questionnaires. A sample mathematics unit for secondary schools (Form 2) in Cameroon was developed incorporating mathematics concepts present in everyday Cameroonian cultural practices. This unit was then tried out with secondary mathematics teachers for their suitability and efficacy in arousing the students' interest towards mathematics and their ultimate successful acquisition of mathematics knowledge. The study was conducted over one full school term (January – April 2003).

5.2 Findings

This study was driven by the idea that successful curriculum change requires a deep understanding of the stakeholders' interest in systemic reform and with the

assumption that stakeholders would hold varying ideologies regarding education in general and mathematics education in particular (curriculum content, purpose and subject areas for curriculum development). Because a reasonable proportion of schools are privately owned (more than 45% as oppose to 55% owned by government), it was decided that the research would be conducted in both government and private school. As is often the case with qualitative research designs, it is virtually impossible to present all the raw data collected from the questionnaires and interview sessions (Miller, Malone, & Kandl, 1992). Responses to the research questionnaires and interview questions are reported using both particular and general descriptions within the framework of interpretive commentary (Erickson, 1986). Rather than present the findings as verbatim responses to each research question or sub-question, the research questions have been grouped into six subsections:

I. The nature of mathematics

II. Mathematics and culture

III. School mathematics curriculum

IV. Curriculum reform process

V. Importance of formal education

VI. Possibilities of an ethnomathematics curriculum

Each subsection will present responses to questions derived from questionnaires and interviews administered to the group, as well as from teacher observation fieldnotes.

5.2.1 The Nature of Mathematics

Using questionnaires and interviews, the stakeholders were asked questions to elicit their understanding and views regarding the nature and philosophy of mathematics. The questions posed were: What is your definition of mathematics?,

What comes to mind when you hear the word *mathematics*?, How would you design the cover of a mathematics textbook?, Is mathematics pre-given or logically derived from axioms?

I.1 The whole group

The overall response from the stakeholders in this study shows that a majority of the stakeholders responded that mathematics is a science geared towards the development of logical and critical thinking and more than four fifths of them said it involved numbers. Only one quarter of the respondents stated that it was a scientific approach to better the living conditions of mankind. Their overall response was based on the argument that though mathematics, especially school mathematics involve a lot of abstract concepts which may not seem directly applicable to the basic needs of mankind, the overall purpose of mathematics knowledge was important in man's[sic] understanding and mastery of his environment.

I.2 The students

There were two questions that explored students' images, views, feelings and notions of mathematics which to some extent suggest their developing understanding of the nature and philosophy of mathematics. These questions were: What comes to mind when you hear the word *mathematics*? How would you design the cover of a mathematics textbook?. In addition, the following questions were also administered to further solicit the students' notions of mathematics: Are history and mathematics related in any way?; Do students know mathematics which they were not taught?.

(a) What comes to mind when you hear the word mathematics?

There were very few differences in the students' developing understanding of the nature of mathematics between students of the public (government) secondary schools and those of the private secondary schools. There was also very little notice-

able difference between students who were taught the ethnomathematics unit and those in the regular mathematics class when the questionnaire was first administered. Most of the students in the four groups characterized mathematics as that involving 'numbers and calculations'. However, when the questionnaire was administered a second time, there was a noticeable difference in the students' attitudes and images of mathematics. Students who took the ethnomathematics unit in both schools showed an improved positive attitude toward mathematics and a broader image of mathematics while students who continued with the regular mathematics unit showed no difference in both attitude and image of mathematics. Since the student questionnaire was administered twice, one prior to the ethnomathematics unit and another at the end of the unit, the findings are reported here with comments grouped into *before* (before the ethnomathematics unit) and *after* (after the ethnomathematics unit).

CCAST Bambili:

In the students' response to the question: what comes to mind when you hear the word *mathematics*?, the findings reveal that most students in the ethnomathematics and non-ethnomathematics group who considered themselves as successful in mathematics (doing well in mathematics such as attaining satisfactory performance in mathematics tasks) stated that the word *mathematics* conjures such processes as 'calculating, solving, counting, comparing, and sharing,' while students who had been less successful expressed feelings of 'hatred, boredom, fear, and getting the lowest score in a test.' Of all the students who responded to this question less than a third from both the ethnomathematics and non-ethnomathematics group stated that they hated mathematics and were always uneasy during mathematics lessons. There was no observed difference in the students responses when the questionnaire before and after the ethnomathematics unit in both groups of students as the following excepts indicate:

Before:

"In short, as for me, when I hear the word 'mathematics' what immediately comes into my head is the most important word: calculation. It makes me feel good." (Student, CCAST)

"When I hear the word mathematics what comes in my mind is I feel like wasting my time, the way mathematics is very difficult, the way I always fail in maths, the way I hate it. I will think of the way I don't understand it." (Student, CCAST)

"Calculation, that boring subject, the way mathematics is very difficult to solve. I feel very bad because math disturbs me much in school and I always fail in math. The way the teacher is teaching is boring too much than the way he or she is unhappy." (Student, CCAST)

After:

"Calculations, addition, subtraction, multiplication, division. I feel bad when I hear the word mathematics because I never pass in math." (Student, CCAST)

"I immediately think of calculation and 'x'. I remember how I don't do well in it. I remember the difficulties of its problems. I think of drawing parms, rectangles, squares, etc." (Student, CCAST)

"When I hear the word mathematics the word that comes to my mind is that the person who says it is calculating." (Student, CCAST)

<u>*CCC Mankon:*</u>

Among the two group of students (ethnomathematics and non-ethnomathematics) in CCC Mankon, most respondents echoed similar verbs as in CCAST Bambili by stating that mathematics conjured such actions as 'calculate, solve, count, compare, share' and the four basic operations (+, –, ÷, ×). About a

quarter of the respondents expressed uneasy feelings when they hear the word mathematics although all of them said they would be happy to learn and excel in it. Most female respondents characterised what immediately comes to their mind in affective terms using such words as uneasy, unhappy, discourage, difficult time, and bored. Most male respondents characterised their state in terms of mathematical processes such as wanting to calculate and to solve. Most female respondents including those who said they were not good at mathematics also expressed the desire to become a mathematics teacher or a mathematician in the future if only they could do very well in it (mathematics). It is worth noting that a female teacher taught this second group of students while a male taught the first group. This is important, as it seems to suggest a correlation between female students and a female mathematics teacher in how students think of mathematics.

Before:

> "Those things that come into my mind are calculation, solving and most subjects like physics, chemistry, geography because these subjects use maths also." (Student, CCC)

> "Calculating, solving, comparing different things, measuring, drawing." (Student, CCC)

> "Since I'm not a maths student, when I hear the word mathematics, I become angry especially when I'm unable to solve the problem." (Student, CCC)

After:

> "When I hear the word mathematics, what immediately comes to my mind is solving and coming out with solutions." (Student, CCC)

> "When I hear the word mathematics I don't longer think of it as complex subject even though the word mathematics sounds like a big

word. I feel that if you concentrate, it is easy as it is for me now." (Student, CCC)

"When I hear the word mathematics, I think of calculating and using the computer. I then begin to feel bad because I like maths but my problem is I don't understand it well." (Student, CCC)

(b) How would you design the cover of a mathematics textbook?

There was no noticeable difference in the description of the textbook cover design between students in the ethnomathematics group and those in the non-ethnomathematics group in both schools when the questionnaire was first administered. When the questionnaire was administered again after the ethnomathematics unit, there was more illustrating and less describing by students of the ethnomathematics group than those in the non-ethnomathematics group in both schools. What remains unclear is whether this difference in response could be attributed to the ethnomathematics unit since there were still some similarities between what students in the ethnomathematics group illustrated and what those in the non-ethnomathematics group described.

CCAST Bambili:

As stated above, there was no noticeable difference between the two groups (ethnomathematics and non-ethnomathematics) describing how they (the students) would design the cover a mathematics text when the questionnaire was first administered. When asked about how they would design the cover of a mathematics text, about half the students either drew geometric shapes both in 2 and 3 dimensions or listed arithmetic operations (+, –, ÷, ×). Color seemed to be an important requirement in the design of a mathematics text as about a third of the students listed colors they would use to beautify the cover and their explanation was

that if the text were attractively designed, then it might not scare away or intimidate less able students in mathematics.

Before:

"I will put mathematics signs on it and I will write the name of the book. I will write the name of the author." (Student, CCAST)

"I will use a colour pencil, a pencil and draw a flower on it. I will write the author's name, the title of the textbook and I will colour it to look attractive so that many people can like to read it and learn mathematics." (Female Student, CCAST)

"... I will put myself in it when I am learning, I will put what is inside and I will also put mathematical signs on it like x, =, +, ÷, –, √, ∑, ∞, ∫. I will also put graphs." (Student, CCAST)

When the questionnaire was administered again, there was a slight difference between the two groups (ethnomathematics and non-ethnomathematics) with students in the ethnomathematics group highlighting the importance of using warm and friendly colors, inviting (less intimidating) titles and captions, and to some extent, a more regionalized or localized title. The increased emphasis in color was especially prevalent among female students while the male students focused more on the general contents of the cover. The following quotes are illustrative:

After:

"*Mathematics for African Schools for Improving the Level of Mathematics*" (Student, CCAST)

"Cover should contain drawings of people conducting an experiment in mathematics like trying to solve a mathematics problem." (Student, CCAST)

"I will use green and purple colors because I think the colors are very friendly and inviting. I will use a bold marker to highlight the title of the book. I will call it *Passport to Mathematics 2*." (Female Student, CCAST)

"I will draw a rectangle, a square, a triangle and paint it red yellow and green and a person calculating mathematics." (Female Student, CCAST)

"I will put some problems that I have solved to encourage people to do this good subject called mathematics that we use in other subjects like physics, geography." (Student, CCAST)

CCC Mankon:

Generally, there was a noticeable shift from describing how the cover would look like to making illustrations of it. A majority of the respondents suggested including mathematics symbols such as geometric shapes and operation signs. More female respondents emphasized the particular color they would use suggesting the importance of color for attracting learners to mathematics. Some of the descriptions were suggestive of the students' sentiments about school mathematics in Cameroon and the desire to make school mathematics easy to learn or at the very least, less intimidating as the following statements from three students indicate:

Before:

"It would look like it is showing a teacher in front of the board with children sitting and trying to solve a mathematical problem or children that have found a solution to a problem and are glad or shouting and jumping in class. The title will be *Mathematics Made Easy for Cameroon School*." (Student, CCC)

"I will design it with an attractive colour like yellow and put some maths equations and some people solving maths. I will like to encour-

age the student to do mathematics. And as the producer, I will put my name and address for people to contact me to know more about mathematics." (Student, CCC)

"I will put some things that will make it look as if there are questions on it and put some signs of subtraction, multiplication, addition, and so on so that when somebody sees it without opening it they will know that it is a mathematics textbook." (Student, CCC)

After:

"I will first start by saying *African Exercise Book* and I will draw a map of Africa to show that we do mathematics in Africa. After that I will write the name, class, subject, date and the colour will be green and I will draw square lines on it to show that it is a mathematics book." (Student, CCC)

"I put students studying mathematics in class and the teacher standing in front of the class. I will also draw people buying and selling things at a market and calculating how much money they have to give as change and how much money they have sold for the day." (Student, CCC)

"I will design the cover by first writing at the top of the cover, Mathematics. Next, I will indicate by drawing some pictures directing how it is being taught in class and sometimes advertising a bit of its importance to the society." (Student, CCC)

(c) Are history and mathematics related in any way?

CCAST Bambili:

Asked whether history and mathematics were related in any way, there was a noticeable shift in thinking between the first and second time the questionnaire was administered. During the first time, a third of the respondents in both the ethnomathematics and non-ethnomathematics group stated that there was no relation

between history and mathematics because mathematics deals with numbers and calculations while history deals with past events.

Before:

> "History and mathematics are related because in Roman numerals, we learn about the history of the Romans and how they developed their numerals." (Student, CCAST)

> "History and mathematics are related in the sense that there are some important events in history which are being remembered due to dates, and dates are made up of figures, and figures are gotten from mathematics." (Student, CCAST)

> "History and mathematics are not related because in mathematics we deal with addition, subtraction, multiplication, division etc. but in history we deal with stories of the past and biographies." (Student, CCAST)

During the second time the questionnaire was administered, only 2 in 20 in the ethnomathematics group and 7 in 20 in the non-ethnomathematics group still said history had nothing to do with mathematics. All those who had initially responded that history and mathematics were related maintained their opinion and further substantiated why by stating some of the following:

After:

> "... history and mathematics are related because in history you have to calculate years of people and they're people who invented mathematical signs in history." (Student, CCAST)

> "There is a relationship between history and mathematics because history which talks about the past told us about the discovery of Arabic and Roman numerals which is taught in mathematics." (Student, CCAST)

Those who maintained that there was no relationship between history and mathematics provided the following logical arguments for their stance:

> "History and mathematics are not related because history talks about what people did in the past while mathematics deals with the calculations in our daily lives." (Student, CCAST)

> "Mathematics and history are not related in any way. History deals with the past and it does not need any mathematics. Mathematics has to do with a lot of calculation and maths characteristics are quiet different from that of history. So history requires just a retentive memory, while mathematics requires a lot of thinking." (Student, CCAST)

For all those who felt that history and mathematics were related saw the relationship in terms of content and process. Content wise, the students cited the presence of Roman and Hindu-Arabic numerals in both subjects; process wise, the cited relationship was the calculation of time between two events as students saw it as the mathematical process of difference or subtraction.

CCC Mankon:

In the initial administration of the questionnaire, three quarters of the students (almost evenly distributed between the ethnomathematics and non-ethnomathematics groups) believed that history and mathematics had nothing in common. The reasons they supplied for this line of thinking are found in the following statements:

Before:

> "History and mathematics are not related in any way because in history we are talking about stories and past events while in mathematics we are talking about addition, multiplication, subtraction, division and we are calculating." (Student, CCC)

"No, history is an art subject and mathematics is a science subject and in mathematics there are some calculations. In history, there is no solving. In mathematics we study what is around us daily while in history we study what has past some years ago." (Student, CCC)

"No because there is no solving of equations in history. History deals with dates and past events while mathematics deals with figures and calculations." (Student, CCC)

"They are not related in any way because history deals with the past and the present events while mathematics deals with calculations. And also, they are not related because in any exams you cannot write history but with maths we must use mathematics in every exams." (Student, CCC)

The second time the questionnaire was administered, more than two thirds of the students (with majority from the ethnomathematics group) now believed history and mathematics were definitely related. This major shift in thinking may signal the students' realization of the presence of mathematics in history and the presence of history in mathematics, as can be seen by the following except:

After:

"Yes, because if someone says the 1st World War began in 1996 and ended in 2003, if you want to get for how long it lasted you have to calculate, which will then be 2003 – 1996 = 7. Therefore the 1st World War will have lasted for 7 years and this is mathematics." (Student, CCC)

"Yes. This is because in history numbers are also used for example, reasons why the British annexed Cameroon. When you start by giving the reasons you will number them and by doing so you are doing mathematics." (Student, CCC)

"Mathematics is related with history in the sense that there are some important dates in history which are represented by numbers, and

numbers are gotten from mathematics. We are also taught of some important things in mathematics which were discovered years ago and that is history." (Student, CCC)

"Mathematics and history are related because in mathematics we learn things which were discovered so many years ago." (Student, CCC)

(d) Do students know mathematics which they were not explicitly taught?

When the questionnaire was first administered, a majority of students in the ethnomathematics and non-ethnomathematics groups from the public school and about half of both groups in the private school said this was not possible. Those in the public school did not change their opinion by much when the questionnaire was administered again whereas those in the private school showed a slight increase in both groups, of those who felt that it was possible to know mathematics without being taught explicitly.

CCAST Bambili:

Asked if it was possible to know some mathematics that one had not been taught, most respondents in both the ethnomathematics and non-ethnomathematics groups said this was not possible unless one had been taught. Only 8 students said this was possible if one had the mathematics textbook and studied on their own. To those students who thought it was not possible to know something unless one had been taught, their reasoning went as follows:

Before:

"... you cannot know something unless you have been taught." (Student, CCAST)

"... one is not born knowing math." (Student, CCAST)

"... a student cannot know mathematics which he or she has not been taught because you cannot go to fetch water without a bucket just as you cannot eat 'achu' without soup." (Student, CCAST)

Students who believed that it was possible to know mathematics that one had not been taught based their response partly on the fact that mathematics is present in our daily lives. These students had a more broad view of mathematics and counting was one of the activities in mathematics:

"Yes, for example, to count money is mathematics, there are people who can count money when they were not taught like me." (Student, CCAST)

"Yes ... because anything you do mathematics must be involved." (Student, CCAST)

When the questionnaire was administered a second time, half of the respondents in the non-ethnomathematics group felt that it was possible to know mathematics which one has not been taught by reading a mathematics text, by using mere common sense or simply by the fact that everyone could count money a process according to them not taught. The other half of the respondents felt that it was not possible to know mathematics when one had not been taught. Some stated that the very fact that mathematics is being taught in school is because one cannot know it until they are taught. Other statements supporting the 'NO' response were:

After:

"No, because you cannot just sit like that and know something when you have not been taught or when you have not heard from somebody or somewhere." (Student, CCAST)

"No, because mathematics first of all is difficult to understand and if you are not taught you can never know something about it. So the

only thing is that they have to teach us mathematics before we can understand." (Student, CCAST)

CCC Mankon:

When the questionnaire was first administered, about half (11 out of 20) of the students in the ethnomathematics group said it was possible to know mathematics that one had not been explicitly taught. Of this proportion of students, a majority saw this possibility in terms of the ability of some students to self-teach themselves wherein a student could study mathematics from a mathematics text and come to know some mathematics without being taught by a teacher or someone else. Among the non-ethnomathematics group, 8 out of 20 respondents said it was possible to know mathematics that one had not been explicitly taught. Of these 8 respondents, 3 referred to intuition as the example of knowing mathematics without being explicitly taught. The following excerpts represent the arguments made by the respondents from both the ethnomathematics and non-ethnomathematics groups:

Before:

"No, because the students are not God who are born knowing everything. Yes it is true some people are naturally talented but no one knows without being taught." (Student, CCC)

"No, this is because you cannot know what you have not been taught. Mathematics is not a simple subject because we do not guess answers." (Student, CCC)

"Yes, I know mathematics that I have not been taught in class because when I go home, I learn from the textbook what I have not been taught in class." (Student, CCC)

"Yes, this is because if you are having an elder that has just passed that class, the person may teach you. You may also read from a text-

book ahead of the teacher so that when the teacher is teaching you should understand him or her better." (Student, CCC)

"Yes, because mathematics is an interesting subjects that needs a lot of reasoning. So one can learn it without being taught by another person simply by reasoning." (Student, CCC)

After the completion of the unit containing cultural aspects of mathematics, responses to this same question showed a marked increase in the proportion of those who thought it was possible for students to know mathematics which they were not explicitly taught. This increase was noticed in both groups although the proportion of students in the ethnomathematics group was higher than in the non-ethnomathematics group. The following statements are verbatim responses of the reasons the students provided as to why it was possible to know mathematics which they had not been explicitly taught:

After:

"It is no because all mathematics that I know I have been taught by my teachers in class and if I don't know or understand I always go and see my elders to show me better." (Student, CCC)

"Yes, because if you are not taught, you can still know it because if you are selling and just calculate it shows that it is mathematics not only calculating money but many other things." (Student, CCC)

"Yes, my illiterate grandparents knew how to calculate money very well even though they were not literate. I say this because mathematics is calculation. And so was I when I was about 5 in nursery school." (Student, CCC)

"Yes, because mathematics is being carried out in everyday life for instance if you are sent to buy bread in the morning and you are given 500 Frs. that you should buy it for 100 Frs., you immediately start calculating the change." (Student, CCC)

> "Yes, in the sense that as the student was growing, he or she knows that '1 + 1 = 2' without telling or asking from a friend or he/she knows that 'a book + a book = 2 books'. God made man and put a little sense in the man's mind. It is just left for the teacher to add a little to what you know." (Student, CCC)

Many of the students' responses seem to suggest that they understood mathematics can only be taught in a formal environment, say a classroom while the teaching of mathematics in informal and non-formal situations was not considered as teaching or learning taking place. This explains why they would consider themselves as knowing that '1 + 1 = 2', the amount of money given to them and even the difference they will receive after purchasing something that requires a balance.

I.3 The teachers

Within the realm of the nature of mathematics, five questions were posed in the questionnaire that sought to reveal the teachers' stances or positions regarding the nature/philosophy of mathematics. These questions were: (a) What is your definition of mathematics?; (b) If you were asked to design the cover of a mathematics text, what would it look like? You can either draw or list the things you would put on the cover; (c) Mathematics has been described by some as a theoretical subject divorced from its human origins. How would you respond to such a description?; (d) How would you respond to the following statements: Different cultures and the course of history have contributed to mathematics, Mathematics exist as pre-given knowledge i.e. mathematics knowledge cannot be created but exist independent of mankind, Mathematics is logically derived from axioms?; and (e) Do teachers expect students to know mathematics which they were not explicitly taught?

(a) What is your definition of mathematics?

All the four teachers saw mathematics as a science and these views were very consistent throughout the research. One of the teachers (Teacher B) in CCC went as far as identifying different types or uses of mathematics. The fact that only two teachers taught the ethnomathematics unit did not seem to influence the teachers already established views about the nature of mathematics. Here is how the teachers defined mathematics:

> "Math is a language of the sciences and plays the role of widening your mind to think and act reasonably and logically." (Teacher A, CCAST)

> "Math is the science that builds up logical thinking in pupils. It is the science of numbers employed in solving day-to-day problems. Thus it is geared towards imparting proper reasoning skills in the learners at the beginning of their studies in math. Furthermore, mathematics involves the building up of theories which serve as framework in various fields e.g. binary theory in computer programs etc." (Teacher N, CCAST)

> "Mathematics is the science of numbers, which has evolved throughout the years and is used in our daily activities e.g. mathematics in the kitchen, mathematics on the farm, mathematics in economics, geography etc or simply mathematics in school." (Teacher B, CCC)

> "Science which involves logical study of shapes, arrangement, quantity, and many related concepts and may fall into the following branches: arithmetic, algebra, analysis, geometry, trigonometry etc." (Teacher K, CCC)

The above quotations suggest each teacher's philosophical position regarding mathematics and it is possible that these positions would have a bearing on how each teacher approaches the teaching of mathematics.

(b) If you were asked to design the cover of a mathematics text, what would it look like?

Of all the four teachers, only one teacher (Teacher B, CCC) suggested making the cover colourful and attractive and only one teacher (Teacher K, CCC) suggested making the cover responsive and closer to the student's environment by including a local cultural background on the cover. Both teachers in CCAST focused on the mathematics content that should be presented. Considering both teachers in CCAST were formally trained, it is surprising to note that both opted for a design that is more abstract and less welcoming in its presentation. Here is how they each described their design:

> "It should carry the operation signs (+, ÷, ×, –) and a small market situation with people buying and selling fowls, other food crops including fruits. There should also be a bricklayer at work." (Teacher A, CCAST)

> "Book covers always have to be made so that a reader makes some sense out of it, or so that they give an impression of what the book is about. Depending on the level for which the book is geared, I would include the title at the top, some maths symbols in the middle showing a bit of what is inside the book and finally the name of the author at the base of the cover page." (Teacher N, CCAST)

> "Some common shapes and symbols, and numbers e.g. triangles, circles; alpha, lambda; the plus, multiplication signs; the set of numbers $\mathbb{N}, \mathbb{R}, \mathbb{Z}$ etc. Some interwoven colours attractive to the user." (Teacher B, CCC)

> "The cover will contain as many mathematical symbols, giving a background view of the environment, or area where the book has been written. Trying to insert the cultural background where the book has been written." (Teacher K, CCC)

(c) and (d) How would you respond to the following statements: Different cultures and the course of history have contributed to mathematics.

All four teachers agreed that different cultures and the course of history have contributed to mathematics. This fallibilist view is in line with Ernest's writing on social constructivism in which he presents mathematics as cultural knowledge, more than a collection of subjective beliefs, but less than a body of absolute objective knowledge. The teachers' responses went thus:

> "Quite true. The Hindus, the Arabs etc developed our present counting numbers and numerals." (Teacher A, CCAST)

> "This is true as maths curricula keep changing to catch up with changing world; from traditional math ways of counting with pebbles to the development of numeral and number words in the different cultures." (Teacher N, CCAST)

> "True because mathematics has evolved to this extent because of interaction of different cultures giving rise to many developments in mathematics skills and reasoning." (Teacher K, CCC)

> "True. Early man had his sheep and cattle. In order to know the size he had to count them. Hence mathematics originated. The word algebra, alpha, sigma, Pythagoras theorem etc are from different cultures and history." (Teacher B, CCC)

(e) Do teachers expect students to know mathematics which they were not explicitly taught?

In response to the question whether teachers expected students to know mathematics which they (students) were not explicitly taught, both teachers working with the ethnomathematics group said yes while the other two teachers in the non-ethnomathematics group said no. Whether this is related to the teachers working on the ethnomathematics unit or not was not clear. What is however evident in the

teachers' responses to this question is that the teachers who held a view of mathematics as an organized body of knowledge tended to disagree while those with a view of mathematics as arising from human daily activities felt it was possible for a student to know mathematics without being taught. Their views were espoused in the following statements:

> "Yes. From observing carpenters or bricklayers students can have very good ideas on geometry etc." (Teacher A, CCAST)

> "No. Because a lot of knowledge is built up when a topic is taught in class or even read by a learner (in the case of out of class study by learner). Though this might involve from the students some remote knowledge of that particular maths it is usually better understood only when there is an instructor to guide them." (Teacher N, CCAST)

> "Yes. If students explore with a lot of interest and determination they can easily discover the basic and related concepts which are required." (Teacher K, CCC)

> "No. Because math requires applications in our day-to-day activities, meaning that ideas should be well taught and explicitly taught." (Teacher B, CCC)

The various positions taken by the teachers in responding to the above five questions suggest that teachers ascribe to more than one view about the nature of mathematics. If this is true, then it is possible that teachers are able to hold varying positions regarding the nature/philosophy of mathematics and access the position which is most appropriate for a given situation. The teachers various positions vis-à-vis the nature of mathematics concurs with Lakatos' argument that no definitions in mathematics are ever absolutely final and beyond revision. As such the history of mathematics should always be given pride of place in any philosophical account.

I.4 The pedagogic adviser

In response to the question 'What is mathematics?', the pedagogic adviser provided the following response:

> "Mathematics is a way of expression ... a form of language."

He supported this statement by arguing that mathematics cannot be pre-given knowledge since it's a form of language and language cannot exist independent of human beings. To him, mathematics is knowledge created by human beings as they come in contact with specific difficulties or specific situations. This knowledge, he maintains is created in the form of (mathematical) models with rules for manipulating them. These rules and knowledge change as man's knowledge of the situation improves. Hence mathematics is not static but changes with man's increased experience of the world. This view of the nature of mathematics espoused by the pedagogic adviser leads him to conclude that since it (mathematics) is a way of expression it is therefore naturally linked to man's culture. Hence mathematics is a cultural product or a product of cultural expression. This view of mathematics as a cultural product suggests that different cultures approach mathematics differently depending on their culture and their experience of the world. Such a view would seem to encourage a need for a cultural approach to the teaching and learning of mathematics.

I.5 The university faculty

The university faculty conceded to the fact that the definition of mathematics depends on who is offering that definition and under certain given conditions. To this end, the word mathematics conjures several things to him for example, it could be seen as "... a way of reasoning. It is thought provoking, and enables critical thinking and this can be achieved through certain specific principles." In offering this view of mathematics, he seems to be suggesting that mathematical knowledge is

acquired only if one followed "certain specific" path of reasoning or line of argument. This is a view of mathematics with an epistemological bent as it seems to suggest that there are specific ways one must go about to acquire mathematics knowledge or to engage in mathematics.

Another statement expressing what comes to his mind when he hears the word *mathematics* has more to do with the uses of mathematics (knowledge and its principles of acquisition) by emphasizing its usefulness to other fields of study such as the sciences. He states, "... mathematics allows other sciences, specifically, the physical sciences to express relations between certain variables." This utilitarian view of mathematics is often used to justify the importance of mathematics and the reasons for studying it thus suggesting that mathematics devoid of a utilitarian bent is ignoble, lesser mathematics or less important.

Another view, which the word mathematics connotes to the university faculty, was that of being a language like any of our many world languages:

> "... mathematics is a language on its own. Because as every other living language, it has its own syntax, its own symbols, its own vocabulary, but as a living language, borrows words from other languages but uses it in its own context." (University Faculty)

These different meanings or images held by the university faculty regarding the meaning of the word mathematics seems to suggest that it is possible to compartmentalize different and sometimes even contradictory views about the subject of mathematics. This is possible since according to fallibilism, mathematical knowledge is always understood relative to the context, and is evaluated or justified within principled or rule governed systems. According to this view there is an underlying basis for knowledge and rational choice, but that basis is context-relative and not absolute. Hence there is no such thing as absolute truth as mathematics transcends any particular individuals This is partly why the university faculty, like

the teachers in the two schools, seem to hold to varying and competing views on what the word mathematics means to him.

5.2.2 Mathematics and Culture

The stakeholders were asked whether history, culture, cultural background, students everyday experiences were important in the teaching and learning of mathematics. If they were important, how often they incorporated these into their mathematics lesson instructions. The stakeholders were then asked to state, on a five-point scale (from most important to least important, or from more relevant to least relevant, or from incorporating these all the time to never incorporating these at all) how relevant or how important these were. Other questions such as: 'Is mathematics culture-free, culture-neutral, or value-free?'; 'Are there any connections between school mathematics and the students' cultural background?'; 'How important are these connections?' were also posed. These questions were used both in the questionnaire and during the interviews to elicit the participants' views vis-à-vis school mathematics and culture.

II.1 The whole group

Most of the questions in this area were posed to the teachers, university faculty and pedagogic adviser. The questions focused on accessing teachers' knowledge of mathematics and culture and how this connection affects their instructional planning and organization of learning experience. Most of the students' questions in this area were of their knowledge of mathematics embedded in their culture or cultural connections of school mathematics.

II.2 The students

Do you find mathematics in your culture in any way? (Give examples to support your answer)

CCAST Bambili:

When the questionnaire was first administered, 29 out of 40 students (16 in the ethnomathematics group and 13 in the non-ethnomathematics group) said mathematics was present in their culture. Clearly a majority of the students in both groups felt that mathematics was present in their culture. The following excerpts illustrate their responses:

Before:

> "When there is a dead celebration, people celebrate and try to share food in the way that everybody will have and when they want to share meat, they count the people so that everybody can have a piece." (Student, CCAST)

> "Yes, I can finds mathematics in my culture because when a boy wants to marry a girl, the father of the girl will ask the boy to give a certain amount of money. I think that is mathematics." (Student, CCAST)

> "Yes, mathematics is present in my culture because in our culture they pay people dancing and they must count the money and they use mathematics in counting the money and sharing it between the people dancing." (Student, CCAST)

> "No, because I don't find mathematics in my culture, I find only my dialect."(Student, CCAST)

Beside the above statements, most students stated that mathematics was present in their culture because in the local market place, people buy and sell which according to many of them is mathematics. Only one respondent maintained in both questionnaires that mathematics was not present in her culture because in her

culture there is no word for mathematics and besides, she had never heard of it. She explained:

After:

> "There is no mathematics in my culture because we do not have a word for mathematics. Otherwise I would have heard somebody use it in the dialect. Also, we cannot write in my dialect so how can we do mathematics?"(Student, CCAST)

What the above statements suggest is that this student holds a view of mathematics as that which resides in the textbook and does not think of the mathematical processes that she performs everyday without pen and paper.

CCC Mankon:

This last item on the questionnaire, which explored the presence of mathematics in students' culture, revealed that when the questionnaire was first administered, 26 out of 40 respondents (11 in the ethnomathematics group and 15 in the non-ethnomathematics group) felt that mathematics was present in their culture in some form. Hence a majority of the students in both the ethnomathematics and non-ethnomathematics groups felt that mathematics was present in their culture in one form or the other. Below are some of their responses:

Before:

> "Yes, because in my culture the amount of plantains or jugs of palm wine to be brought if asked by the chief to any celebration is calculated using mathematical symbols and the total to be brought is then given in terms of mid-size calabashes." (Student, CCC)

> "Mathematics is not present in our culture because our people have not yet got in touch with what we call mathematics. They lack teachers

to teach them mathematics and that is one of the reasons that I want to improve on mathematics very well." (Student, CCC)

"Yes, in my culture there is the tendency of doing mathematics because when you are married you must teach it to your wife and children so that those who are jobless can start a new life either by selling in a store or counting money through trading and other businesses like banking." (Student, CCC)

"Yes, I find mathematics in my culture when a man wants to get married to a woman from my tribe, certain things are demanded from him. But in situations where they cannot be easily got, the people calculate the price of all those things and ask him to pay in cash." (Student, CCC)

"Most people in my village do not like mathematics because it is too difficult so we don't find it in our culture" (Student, CCC)

However, when the questionnaire was next administered, all the students in the ethnomathematics group said mathematics was present in their culture while 3 students in the non-ethnomathematics group still thought that mathematics was not present in their culture. Those who felt that mathematics was present in their culture provided examples of occurrence of mathematics similar to those stated above as well as the following statements:

After:

"Yes, in my culture I find mathematics a bit like when calculating the '*country Sunday*' (traditional Sunday), market day, and the day of a chief. Mathematics is also taught in my language." (Student, CCC)

"Mathematics is present in my culture when: tailors use mensuration in sewing, bricklayers use mensuration in building, carpenters use mensuration in roofing and it is also compulsory in certificate and public exams." (Student, CCC)

Those students who still maintained that mathematics was not present in their culture substantiated this by statements such as:

> "We don't have mathematics in my culture because in my village, we have only primary schools and in primary school you learn only arithmetic. Mathematics is done only in the secondary school which is far away from my village." (Student, CCC)

> "In my culture we don't have mathematics because it is very difficult. People use common sense which is different from mathematics." (Student, CCC)

> "Mathematics is not present in my culture because we don't not calculate the area or find the square root of numbers. What we do in my culture is mostly arithmetic which is easier than the mathematics we study in school." (Student, CCC)

The above statements suggest that in both the public and private schools most students felt that mathematics was present in their culture although the word mathematics was never uttered. The students seem to be identifying the presence of mathematical processes in their culture or daily lives or the use of mathematics knowledge in certain cultural situations.

II.3 The teachers

On the question of how often they presented a historical or cultural background to the mathematics they teach, all four teachers (2 who worked with and taught the ethno-mathematics unit and 2 who taught their regular unit not influenced by ethnomathematics ideas) responded that they sometimes but not regularly presented a historical or cultural background to the mathematics they are teaching. But when asked how important and relevant students everyday experiences and cultural background were when they plan their lesson instructions, both teachers responded that this was relevant or very important. This suggests that

while both teachers agreed on the importance of students' background knowledge to acquiring new knowledge and the importance of relating what students were learning to what they experienced everyday, the teachers did not incorporate these ideas regularly. In response to whether teachers can use students' in-school and out-of-school knowledge to connect the mathematics practices in these contexts both teachers (2) of the ethnomathematics group responded in the affirmative giving the following statements to support their opinions:

> "Yes. When one recognizes the fact that maths exists in the various cultures, students' experiences are very important as they bring the students into real practical situations. Formal maths can be imparted with examples drawn from the homes. This instils confidence in students and makes learning easy." (Teacher A, CCAST)

> "Yes. By planning our lessons to include practical experiences, this helps in building up examples which bring the math knowledge closer and easier to understand. A visit to an industrial firm would facilitate students' understanding of functions as this would be used to describe how the plan in the firm operates." (Teacher K, CCC)

II.4 The pedagogic adviser

Two main questions were posed on the nature of the relationship between school mathematics and culture and how the latter affects the teaching and learning of the former. These questions were:

(a) *Is mathematics and culture related in any way?*

(b) *How is the teaching and learning of school mathematics affected by this relationship?*

To the question on whether mathematics and culture were related in any way, the pedagogic adviser began by first looking at what mathematics is and what mathematics knowledge is. He argued that if mathematics is a way of expression, then it is a form of language and since language cannot exist independent of human beings, it must be logical to assume the existence of a cultural connection. Following

his line of argument, the pedagogic adviser is clearly suggesting that mathematics and mathematical knowledge are not *pre-given* (i.e. do not exist independent of mankind) but *created* by human beings to solve specific problems or situations.

> "Mathematics is a way of expression. In that light, it is a form of language. The question to ask then is: Can language exist independent of human beings? It can't. In that case, we cannot consider mathematics as pre-given knowledge. It [mathematics] is knowledge created by human beings as they come in contact or in face with specific difficulties or specific situations. This knowledge is created in the form of mathematical models and rules for manipulating them. These rules and the knowledge change as man's knowledge of the situation improves. So we are saying in effect that mathematics is not static. It changes with man's experience of the world, man's increased experience of the world. As a way of expression, it is naturally linked to man's culture. If we say that the content of mathematics is almost universal, that does not mean that every person or every culture approaches it with the same frame of mind, or with the same facility. Because people approach mathematics differently depending on their culture, and their experience of the world." (Pedagogic Adviser)

When pressed on what he meant by "...people approach mathematics differently depending on their culture, and their experience of the world", he used an example to illustrate how mathematics is embedded in culture and how this relationship therefore influences mathematical thought processes, representations and symbolizations. This is captured in the following statements:

> "When you look at certain things in mathematics, in statistics for example, you name a certain chart a pie chart why? I did not know the meaning of this until I learned of a thing called 'apple pie', which is some sort of a cake which is round in shape. That explains the origin of the pie chart. So if you approach the concept pie chart without knowing what a pie is, your interpretation will be quite different. But if you have at the back of your mind the apple pie as a circular cake, then you know why it is called a pie chart and you interpret, in fact you approach it with more insight. So in the light of that, you see how

culture gets into mathematics. Every mathematical element can be traceable to one cultural element in one form or the other. Our present number system originated from the Arabs. It is true that it has been modified quite a lot by the Europeans and the Americans as it is today but it still has a lot of cultural background attached to it. So I think that history is important. It is very important for us to know how some of these elements originated. We will appreciate them better and we will easily tie them to their cultural background, when we are explaining them especially to learners." (Pedagogic Adviser)

"Well, from the definition of mathematics, we say it's a way of expression. Any way of expression is culturally bound. The way one expresses themselves depends on their culture. And the way one approximates, one reasons, one calculates, is culturally bound. And if mathematics develops from this, then you cannot divorce it from culture." (Pedagogic Adviser)

II.5 The university faculty

On whether mathematics existed as pre-given knowledge, the university faculty responded that mathematics was dynamic, culture free and some aspects of it [mathematics] were based on axioms. In response to the questions:

(a) *How often do you present a historical background to the mathematics you teach?;*

(b) *How often to do you present a cultural background to the mathematics you teach?*

The university faculty responded "sometimes but not regularly" but when asked how important or how relevant were the students' everyday experiences in lesson planning and mathematics learning, the university faculty's response ranged from 'relevant' to 'crucial'. These responses suggest that while the university faculty ascribes to the fallibilist view of mathematics in which history and culture are germane, these views are not explored or encouraged among student teachers. This is partly due to the fact that these teachers are being prepared to teach students preparing to write the GCE or Bac, exams which do not test for that kind of knowledge. As result, there is no need wasting time on developing or encouraging these views.

Another reason is more a logistic one based on the fact there are only two faculty members in mathematics education which makes it difficult to explore these views given the workload for each faculty member.

5.2.3 School Mathematics Curriculum

Five general questions focusing on the school mathematics curriculum guided the interviews with the teachers, pedagogic adviser and the university faculty while one question was used in the student questionnaire to collect information regarding the school mathematics curriculum. The five general questions were: (1) What purpose was the present mathematics curriculum designed to serve? (2) To what extent has this purpose been served? (3) What flaws in the curriculum itself could have undermined its effectiveness? (4) How could these flaws be eliminated and/or remedied? (5) What mathematics should be taught to Cameroonian children? Why? There were two questions on the student questionnaire focusing on the school mathematics curriculum: (i) What can be done to make mathematics more 'interesting' to you?, (ii) Should mathematics remain a compulsory subject at the secondary school?

III.1 The whole group

The general feeling expressed was that the present mathematics curriculum was designed to graduate students who will move on to further studies abroad with less regard on returning home to put those skills to use in the community. The complete reliance on an examination intended for those to proceed to higher education has left many graduates the inability to be self-reliant and the total reliance on the government to absorb them into the public service which has not been possible. For the whole educational system to centre around exams meant for the top 20% of students has led to teaching for exams and not for understanding. The general

consensus was that a way forward would require major curriculum reforms with a focus on self-reliance and self-sustainability. There was a general feeling that the kind of mathematics that should be taught to Cameroonian children should be one that besides developing numeracy skills, should equip them with skills to become useful to the community and also be able to compete with children in other parts of the world.

III.2 The students

(i) What can be done to make mathematics more 'interesting' to you?

This question was intended to solicit students' suggestions regarding the current state of the school mathematics curriculum and ways at addressing the issues plaguing the mathematics curriculum. In response to the above question, a majority of the students in each of the four groups in both schools suggested that the government should send well-trained teachers who are less boring and are enthusiastic about the subject. A third of the students (31) in all the groups also suggested the need for good textbooks and the need for mathematics knowledge that can be easily applied to daily life. Of all the student responses, 16 in 80 students suggested the need to introduce a multi-method approach to problem solving in school mathematics, as they believe that this would allow them to choose a simpler method to solve a given problem rather than memorizing particular algorithms. 8 in 80 students suggested eliminating the variable 'x' in mathematics as that would make mathematics more interesting and less difficult since they would not have to look for 'x' any more. To them, the use of the letter 'x' as an unknown or as a variable carries with it the connotation of difficulty or complexity. Additional suggestions included the need for government assistance in mathematics texts and learning resources as well as additional mathematics periods per week to allow them better understand the processes during problem solving.

(ii) Should mathematics remain a compulsory subject at the secondary school?

This question was posed to the students prior to and after the ethnomathematics unit. The responses are therefore recorded in the two instances – *before* the ethnomathematics unit and *after* the ethnomathematics unit.

CCAST Bambili:

On the question of whether mathematics should remain compulsory in the secondary school, when the questionnaire was first administered, most students in both the ethnomathematics and non-ethnomathematics group felt that mathematics should continue to be compulsory because it is important in life and in other school subjects. When the questionnaire was administered again, only 2 students in the ethnomathematics group and 1 in the non-ethnomathematics group felt that students should still be able to opt out of doing mathematics since some are not very good at it. Most students who felt that mathematics should continue to be compulsory at secondary school saw the importance of its utilitarian aspects while the few who thought it should not remain compulsory argued that their performance in school mathematics was affecting their overall performance in school. Some of the frequently stated reasons were as follows:

Before:

> "I think so because it is used in our daily lives e.g. if you want to do a job such as banking, you will have to know how to calculate." (Student, CCAST)

> "It should remain compulsory because we need mathematics in every thing we do e.g. calculating money." (Student, CCAST)

> "Yes, because without mathematics we cannot do anything because mathematics is connected with our daily lives." (Student, CCAST)

"...It should not be compulsory because some people do not want to do it in the future and some people hate it because it can dislocate the brain." (Student, CCAST)

"It should continue to be compulsory because in a situation like the GCE, you cannot do without mathematics." (Student, CCAST)

After:

"It should be compulsory because what you know now in mathematics cannot help you so you need to learn more." (Student, CCAST)

"... because mathematics is needed in every situation in life e.g. counting money, doing business." (Student, CCAST)

"It should remain compulsory because you cannot be a scientist or engineer without knowing maths." (Student, CCAST)

"It should not be compulsory because some people don't like it and others like it. It should also not be compulsory because it is boring when doing it." (Student, CCAST)

A third of the respondents in both the ethnomathematics and non-ethnomathematics groups saw the importance of mathematics remaining a compulsory subject because it was one of the subjects written in the G.C.E. and most other public examinations. It should be noted that these students are in the last grade level before embarking on the rigorous preparation for the G.C.E. Ordinary Level which will be written three years from now. And in the GCE examination all students are automatically registered to write the exam in mathematics although there is no penalty apart from simply receiving a failed grade in the subject for those who elect to sit out. Critics of the compulsory policy of the secondary school mathematics have spotted this as the weakness of the policy and would like the policy to

be revised to ensure that students do not only register by actually attend the mathematics classes throughout the entire programme.

CCC Mankon:

On the question of whether mathematics should remain a compulsory subject at the secondary school, 14 out of 20 students in the ethnomathematics group and 16 out of 20 students in the non-ethnomathematics group said it should remain compulsory when the questionnaire was first administered. On their reasons why it should remain a compulsory subject, 11 students in the ethnomathematics group and 10 students in the non-ethnomathematics group said because it was considered a prerequisite for admission into high school. Those who felt that it should not remain a compulsory subject argued that not everybody was good at mathematics and so people should have a choice of whether to do it [math] or not. Some of these respondents did admit however that they were aware of the usefulness of mathematics in their daily lives. The following excerpts were fairly common among the respondents who said it should remain a compulsory subject:

Before:

> "It should remain compulsory because without mathematics you cannot reason well, think well. You will always be saying things that are off. In Cameroon there is no concours without mathematics and if you don't know mathematics you write a concours and pass in other subjects, you may be forced to repeat because of mathematics." (Student, CCC)

> "In secondary school mathematics is a compulsory subject because you must have it at the Ordinary Level examinations before you can be admitted to high school." (Student, CCC)

> "This is because, for instance my elder sister found difficulties in the second cycle when she was in A3 (which is economics, history, litera-

ture) and she had difficulties in economics because she disliked and put no interest in mathematics and had no basic idea of it." (Student, CCC)

"Yes. This is because mathematics is important in everyday life and without the knowledge of mathematics one cannot be able to run a business." (Student, CCC)

Those who felt that mathematics should not remain compulsory argued their case as follows:

"No because not everyone understands it or even like it. For example I myself do not understand it." (Student, CCC)

"No it should remain compulsory because in the course of calculations some students' brains become offset. Also not all students like maths because they may not involve themselves in any occupation that will make them to be calculating things. When some students solve mathematical problems over and over, they develop a mental problem later." (Student, CCC)

When the questionnaire was administered a second time, all 20 respondents in the ethnomathematics group and only 14 instead of the previous 16 respondents said it should remain a compulsory subject at the secondary school. On their reasons why it should remain a compulsory subject, more than half of the respondents said because it was needed in their daily lives and also because it developed their reasoning faculties. A good proportion of the respondents said because it was present in all public examinations. Those who said it should not remain compulsory cited difficulties in learning mathematics and the preference to chose what they liked to study.

After:

"It should remain a compulsory subject at the secondary school because mathematics is interesting if only you know it. More to that though it is difficult so we should try to study it better but the minister [of education] should find any method that students should not be running away from it." (Student, CCC)

"Yes, because we are in the computer age and you cannot know how to work on a computer when you don't know mathematics. So it should remain a compulsory subject in school." (Student, CCC)

"Yes, because a student cannot leave secondary school and go to any office or bank without mathematics. So it should remain a compulsory subject so as to encourage the student to know mathematics very well and when they leave and go to any place there will be no problem in solving mathematics." (Student, CCC)

"No, because I don't like it. It is too difficult to learn it and it is difficult to understand it." (Student, CCC)

"Yes, because it deals with our daily life activities and because we cannot live without mathematics." (Student, CCC)

"No, it should not remain a compulsory subject since in the high school you chose what series [subject combination] you want to study, some of which do not have mathematics." (Student, CCC)

"Yes, this is because it helps people to know how to calculate even money. Mathematics is almost compulsory in all professional exams. There is no concours in the country that you can write without mathematics. Also, maths makes students to be good in calculations. Hardly will you find any highly or richly regarded person in the society and the government without mathematics." (Student, CCC)

Worth noting in the students' responses is that even students who were not succeeding in mathematics still felt that it was necessary to maintain the compulsory

nature of the subject at secondary school because mathematics knowledge was important in life. This is a point the government may need to consider and decide on how to go about ensuring that students are made to stay in during mathematics lessons.

III.3 The teachers

(1) What purpose was the present mathematics curriculum designed to serve?

In response to this question, three of the teachers while lamenting the inappropriateness of the school mathematics curriculum agreed that the mathematics curriculum being used in Cameroonian secondary schools was inherited from the former colonial government and was intended for the General Certificate of Education examination with the hope that successful students would be able to pursue studies abroad especially in the United Kingdom. The following statements below attest to their dissatisfaction with the curriculum, sentiments commonly espoused by secondary school teachers in Cameroon.

> "...the curriculum was adapted from the British and French and as such, one could say it was intended to enable Cameroonians carryout studies in the UK." (Teacher A, CCAST)

> "...there is actually no national curriculum for mathematics for the country. And what we are using, not that we are not using any form of curriculum but it is what we inherited from the colonial masters which have not been adapted to our own situation. So practically it's a syllabus, an examination syllabus ... broken down into schemes of work for the various Forms (grade levels), ... to prepare students for the General Certificate of Education (GCE) examinations." (Teacher N, CCAST)

> "It's unfortunate that the mathematics curriculum was developed for the purpose of an examination, that the mathematics student's success is measured only in terms of that examination. And that's why the curriculum was developed. The mathematics curriculum has never

been measured as a knowledgeable subject that you can just test everybody but the curriculum has been developed as a measure of the degree of examination and not just knowing mathematics." (Teacher K, CCC)

Only one teacher (Teacher B, CCC) believed the curriculum was intended to develop in the students, skills that will make them useful citizens.

"...it was intended to equip students with the necessary skills to be useful not only to themselves but to the entire nation tomorrow." (Teacher B, CCC)

This view of citizenship education concurs with the stated educational goals at the dawn of independence but had never been revised to reflect the changing realities of today. Post-independence educational policies in Cameroon, as far as contextualization was concern, showed very little regard for the various local cultural practices as a source of knowledge. Little wonder why the school mathematics curriculum has not changed by much since the 1960's and this has contributed to very little (educational) development.

(2) To what extent has this purpose been served?

Assessing the success to the curriculum according to the teachers really depends on the intended aims of the curriculum or of formal education. All the teachers expressed disappointment with the performance of the students especially in national examinations like the GCE or the Baccalaureate. They maintain that if the purpose of the curriculum was to enable students pass the national examination, then it could be concluded, and rightly too, that the purpose of the curriculum is not being served. They all fault the curriculum and not the students on the basis that the curriculum was intended for the top 20% of students but is being administered to all

the students. The following statements capture their feelings regarding the level of success with the curriculum.

> "This has to do with the educational policies in the country. Cameroon's educational policies are still that of mass education – trying to make the majority of the people read and write. That is the philosophy of education in Cameroon. And so if that is the aim of education for Cameroon, then one would say that the goals at least are being achieved because at the beginning, the colonialist did not aim at producing producers at the end of the course. They were just geared at making people read and write to be able to find their way around." (Teacher A, CCAST)

> "If the Baccalaureate and GCE examinations were the reasons for developing the mathematics curriculum for secondary schools in Cameroon, then one could say that the purpose is not being served well since the failure rate in the examinations is very high." (Teacher N, CCAST)

> "We are not succeeding very well. Because of 1) our foundation, 2) even those who manage to come out without mathematics and the government says if you don't have mathematics no jobs for you, no further education, people are still going ahead, the government is not keeping to those rules. So what makes a student feel like it is important I must do it (mathematics)? ... If you say mathematics is compulsory, then establish measures to ensure that students follow that compulsory nature of it. So I think that we are failing. Making it only for a few." (Teacher B, CCC)

> "We are not. We are failing woefully. Because the tendency is not to instil mathematics in the students but to get the students write the mathematics for that examination. And as a result some students are finding it very difficult to study that mathematics of that examination." (Teacher K, CCC)

(3) What flaws in the curriculum itself could have undermined its effectiveness?

All the teachers agreed that the main flaw in the curriculum had to do with the fact that it [the curriculum] is determined by the national examination which the students will be writing instead of the curriculum determining what should be tested in the examination such as the GCE and the Baccalaureate. As a result, the teachers tend to focus more on preparing students for the exam instead of teaching for understanding. This view is captured in the statements below:

> "...we produce consumers and not producers. ... most of what is done is solely for the purpose of the exam (GCE). As such the teacher is focused on preparing students to be able answer questions at the end of the course. Which is not good. That is like rushing to the answer without understanding the processes. They need to pass the GCE quite all right. But they have to understand what they are doing." (Teacher A, CCAST)

Another flaw to the curriculum, which was also echoed by all the teachers, is captured in the excerpts below which focus on the fact that the curriculum is meant for the exceptionally talented students but is administered to all the students. He states:

> "We also realize that the curriculum we are using in mathematics now is what the colonial masters left way back at independence. And this was mathematics for the top 20% of students. Now we are teaching it to all the students. Which means that we are assuming that all of them are supposed to be very good, which is not true. And that brought us to thinking of coming up with a project to re-examine the curriculum." (Teacher N, CCAST)

One of the teachers believes that the continued failure in educating children mathematically is also attributable to the educational policies and quality of teachers vis-à-vis the pedagogy and mastery of the subject matter.

"We are not explicit because we memorized the processes and went and passed our exams. ... The student fears mathematics for the good reason that some of us were not well educated mathematically. The teacher training is a government arrangement. And the government curriculum, when the government says this subject is compulsory but fails to set the rules for ensuring that compulsory nature, hence the students are really not motivated about it." (Teacher B, CCC)

"...if we the people had actually realized that mathematics is practiced consciously and unconsciously, the curriculum would have just been a guide, it would have not been something implanted that this is what you have to cover at this level. It would have just been a guide that would help a child or anybody go through and learn mathematics." (Teacher K, CCC)

While the teachers partly blame the curriculum for the failure of students in mathematics, it can be said that simply revising the curriculum cannot eliminate the flaws and improve performance. A major review of the educational policies is what may be required.

(4) How could these flaws be eliminated and/or remedied?

A starting point for eliminating the flaws in the curriculum according to two of the teachers (both teaching in CCAST Bambili), is by clearly stating the learning objectives/outcomes of the subject in terms of skills acquisition. The teachers also believe that designing other ways of assessing student learning such as continuous assessment should be considered. While the two teachers in CCAST Bambili were focused more on the learning outcomes and alternative assessment methods, those in the private school felt the need to create a balanced curriculum by emphasizing real life applications of mathematics. To them, this is essential for self-reliant development.

"...I would like the curriculum to specify exactly what the student would be able to achieve studying that topic. ... There should be a balance between passing the GCE and knowing what you are studying. Sometimes, certificates don't speak for themselves." (Teacher A, CCAST)

"School mathematics is not supposed to just be examination oriented, not to talk of examination oriented towards a particular examination board. Because what would happen when we shall have more than one examination board? Each will come up with its own syllabus. An end of course examination should be included to test part of a curriculum." (Teacher N, CCAST)

"We don't find agriculture aspects in the mathematics curriculum and yet we are an agricultural country. With the presence of computers in our society, I would have loved it to be incorporated into the curriculum as the excitement of their presence may motivate some students.... In all, we need to include practical aspects of mathematics e.g. mathematics in weaving, mathematics in farming, etc." (Teacher B, CCC)

"...there should be a level where we can think of bringing students to realize the importance of mathematics and doing mathematics for its usefulness in life rather than just to pass an exam." (Teacher K, CCC)

(5) What mathematics should be taught to Cameroonian children? Why?

Most of the teachers (3 out of 4) suggest the need for a curriculum with the practical application of mathematics knowledge as it central focus. They argue that since not every student will be able to proceed to university, there is no point in having one curriculum whose main focus is in preparing students for advance studies in mathematics. It is necessary to create alternative programs for those students who would not proceed to university. These alternative programs, they argue, will allow those students who do not proceed to university to be able to look

for employment or create their own employment by applying their mathematics skills to their daily lives.

> "When I look at the present situation, we turn out students from our schools and then we turn around and cry that they don't have any jobs. Now, you cannot send a child to school solely to be employed by someone else always. You should bring up a human being to be self-reliant, to be self-sufficient. This means that somebody coming out of school should be able to produce. So we should bring up producers and not consumers. So we should emphasize those areas that would produce skills as in carpentry, building construction, etc. We should therefore develop a curriculum that is responsive to our local needs." (Teacher A, CCAST)

> "I would like to see the curriculum with topics that would develop in the students, problem-solving skills especially problems encountered in their daily lives. Which means it should include topics which even if the student were not to continue with mathematics in the high school, they should be useful, that student should be useful; it should also be topics that would develop computation skills in the students; it should also be topics that would develop electronic skills if they have to get into the computer world they should have them even if the uses are not readily available. I would also like to include topics that would help them trace some historical and cultural roots for some of the maths concepts such as modular arithmetic." (Teacher N, CCAST)

> "We need a mathematics curriculum that can produce useful Cameroonians, mathematics that can get people to create jobs for themselves, mathematics that can develop the minds of the students to be logical thinkers." (Teacher B, CCC)

> "Developing a curriculum that can help demystify the school mathematics is necessary if we want to encourage students in mathematics. This will require developing mathematical concepts by using local examples or situations. It is important for students to realize that mathematics exist within their surrounding and that everybody can do mathematics and succeed." (Teacher K, CCC)

(a) How important are the following qualities when deciding on a mathematics text?

On a scale of 0 – 4 (0 = not important, 1 = slightly important, 2 = important, 3 = very important, 4 = crucial) responses to all the five items ranged from important to crucial with both 'correctness of content' and 'relevance to the national examination' being seen as crucial. Similar to the university faculty and pedagogic adviser, the teachers all stated that 'relevance to the national examination' and 'correct of content' was a determining factor in deciding on a mathematics text. But with a limited number of texts and a majority of them printed abroad, these preferences often do not play a major role especially as the texts are prescribed by the ministry and must be followed.

(b) To what extent would you agree or disagree with the following statements?

On a 5-point scale (0 = strongly disagree, 1 = disagree, 2 = neutral, 3 = agree, 4 = strongly agree), all the teachers in both CCC Mankon and CCAST Bambili either agreed or strongly agreed with statements (a) the mathematics curriculum should be seen by all pupils as relevant to their future lives, (b) the mathematics curriculum should incorporate elements of the cultural histories of all the people of the region, and (d) the mathematics curriculum should resonate, as far as possible, with diverse home cultures. One teacher disagreed with statement (c) the mathematics curriculum should be experienced as "real" by all children.

III.4 The pedagogic adviser

(1) What purpose was the present mathematics curriculum designed to serve?

In response to the above question, the pedagogic adviser doesn't feel that the mathematics curriculum was even 'designed'. To him, it is not appropriate to use the word 'designed' since the government holds the prerogative to curriculum reforms

and there has been little or no attempt since independence at reforming school curricula not only in mathematics but in all other school subjects. According to him,

> "Actually this curriculum was adopted, not designed by the Cameroon government. It's a colonial heritage, you see, we had the London GCE at independence with school in this part of the country. Then in 1966/67, the Cameroon GCE was introduced and patterned after the London GCE. So, it's actually a colonial heritage as far as I am concerned. It was meant for the top 20% of the school population but is being taught to everybody. The remaining 80% is simply not responding because the program wasn't meant for them."

The above statements suggest one of the main problems plaguing (mathematics) education in Cameroon and other formerly colonised regions of the world – the degree of irrelevance and the non-responsive nature of school curricula experienced by children in these countries. It is understandable why the level of employment remains high because the kind of education being offered is besides being outdated, neither self-reliant nor self-sustaining. Such a system of education continues to rely on external forces for curriculum reform and innovation.

(2) To what extent has this purpose been served?

The pedagogic adviser believes that it is very difficult to know if success is being made or not because the aims and goals of mathematics education are not clearly stated by the government. Given the absence of statements of goals by the government, one could argue that we are succeeding if the intention is to provide mathematics education just for the top 20%. But if the goals of mathematics education were broadly stated to include the entire school going populace, then one can say that the objectives are not being met as the failure rate of students in national examinations like the Cameroon GCE and the Baccalaureate continue to be very low (below 50%). This situation is captured in the following statements:

"... our program is still patterned after the London GCE and ... was meant for the top 20 percent of the school population. Now, what happens to the bottom 80%? They are not just responding. Now, when you go and take your GCE certificate and you have a grade of 'U' in mathematics, does it mean that your mathematics knowledge is zero? I mean, what does a 'U' in the Cameroonized London GCE represent in terms of mathematical ability? Certainly it does not represent nil mathematical ability. That's the problem. The 80% of the populations is not simply responding because the maths program is not prepared for them."

(3) What flaws in the curriculum itself could have undermined its effectiveness?

One of the flaws in the school mathematics curriculum according to the pedagogic adviser is the very nature of the curriculum. The other has to do with government's decision in making the learning of mathematics compulsory for all students in secondary school. He suggests that if the curriculum were reformed to make mathematics more meaningful and responsive to students, and different syllabuses created for the different ability groups of students then it won't need to be made compulsory for all students to learn. He states,

"The first problem emanates from the fact that we have only one program for all students in the secondary schools (first 5 years of secondary education) writing the GCE Ordinary Levels examinations. That's not right. We should have alternative syllabuses for students of different abilities. That's the first thing we should do. If you look at GCSE, there are at least four syllabuses for Ordinary Levels, so that you give every student the opportunity to do some form of mathematics. That's the first thing I would like to see done in our school system if I were given the opportunity. The next thing will be to be able to create situations where we develop support materials. There are a lot of materials available, which could be developed, but they are not easily accepted. It is necessary to develop a situation where teachers can create materials and these materials can then get into the school system."

One often cited impediment to the successful implementation of the secondary school mathematics curriculum is the lack of school textbooks as most of the texts used in Cameroon are either produced abroad or donated by foreign governments. As the pedagogic adviser decries,

> "...most of our maths programs have been adopted from abroad. We've tried to modify them but the modifications are still limited by the fact that we rely a lot on textbooks from abroad, on examination materials from abroad, on teachers and experts from abroad. ...In fact more than 80% of our textbooks come from abroad, or are produced by authors from abroad."

(4) How could these flaws be eliminated and/or remedied?

The pedagogic adviser believes that the main flaw to the current curriculum lies in the fact that it was intended for the top 20% of students but is being taught to everyone. He believes that the first step towards reforming the situation is the creation of another mathematics program for the bottom 80% of students. He argues,

> "If we were to allow the present math program to be taught just to the top 20%, we will not face the problem we are facing. We will not need to make it [mathematics] compulsory. So if we designed another curriculum to meet the needs of the remaining 80%, then they would respond more."

Another cited flaw in the curriculum lies at the very heart of the nature of mathematics and mathematics education being emphasized in the two inherited systems of education (English and French). Because Cameroon practices two systems of education that it inherited from its colonial masters, the argument being made is that school mathematics in the English system is viewed as a service subject and is approached as such whereas in the French system, emphasis is on the philosophical orientation. The following excerpts by the pedagogic adviser illustrate this point:

> "The Anglo-Saxon culture regards mathematics 80% of the time as a service subject meant to enable you solve practical problems in engineering, science and so on. That's not the case with the Francophones. They do mathematics from a theoretical point of view, abstract point of view, and philosophical point of view, defining the rules and then following them logically and arriving at what they want to do. I'll give you an example: a Francophone can define a Riemann integral meticulously and deal with it to the end, but if you ask him to calculate a definite integral from say, 0 to π, of a certain function, he will get stuck. That's the basic difference."

Developing a national curriculum may be what is needed here. But the pedagogic adviser seems to believe that for that to happen, a change in "thinking" (regarding the purpose of mathematics education) will need to occur first. With a national curriculum, it will be possible to develop an appreciation for the various ways in which people come to know without looking at any particular approach as inferior or superior.

> "[T]he problem is that the underlying philosophy of mathematics education differs between the two systems of education. Now, the Anglophone regards mathematics as a service subject and approaches it from a very practical point of view. The Francophone regards mathematics as a philosophy and approaches it from a very abstract philosophical point of view, and does not stress so much on the practical implications of mathematics. Now, unless these two philosophies are made to merge, which is quite difficult, we will always have differences in mathematics no matter what you do. ... And therefore, the difficulty here is not the mathematics program, but the thinking."

(5) What mathematics should be taught to Cameroonian children? Why?

It is the pedagogic adviser's belief that the kind of mathematics taught to Cameroonian children should be one that (1) enables them to be able to solve everyday problems easily, (2) develops critical thinking in children, (3) provides the child-

ren the skills needed to lead a better life, and (4) helps children pursue further studies especially in the sciences requiring a good knowledge of mathematics.

(a) How important are the following qualities when deciding on a mathematics text?

Five items and a 5-point scale were used to access the faculty's response to the above question. The five items were: a) correctness of content, b) adaptation to students' abilities, c) preparation of the students for the text by what they have already learned, d) preparation for what they would have to learn in the future, and e) relevance of the text to national examinations. On a scale of 0 – 4 (0 = not important, 1 = slightly important, 2 = important, 3 = very important, 4 = crucial) all the five items were rated as either very important or crucial, with both 'correctness of content', 'adaptation to student abilities' and 'relevance of the text to national examinations' being seen as crucial. This particular question captured the attention of the pedagogic adviser because textbook production is a major problem and most of the textbooks in use in secondary schools in Cameroon are produced abroad by authors who often not familiar the differences in culture. Statements a, b, c, and d were seen as crucial while statement d was seen as important.

(b) To what extent would you agree or disagree with the following statements?

Four items and a 5-point scale were used to access the faculty's response to the above question. The four items were a) The mathematics curriculum should be seen by pupils as relevant to their future lives, b) The mathematics curriculum should incorporate elements of the cultural histories of all the people of the region, c) The mathematics curriculum should be experienced as "real" by all children, and d) The mathematics curriculum should resonate, as far as possible, with diverse home cultures. On a 5-point scale (0 = strongly disagree, 1 = disagree, 2 = neutral, 3 = agree, 4 = strongly agree), the pedagogic adviser agreed with statements (b) and (c) while strongly agreeing with statements (a) and (d).

III.5 The university faculty

(1) What purpose was the present mathematics curriculum designed to serve?

There is no clearly stated government policy on mathematics education in Cameroon. However, statements suggesting the purpose of mathematics education in Cameroon could be gleaned from the introduction to the secondary school schemes of work, a publication of the Cameroon General Certificate of Education (GCE) Examination Board which state: "(i) to train students to become mathematically literate; (ii) to prepare students for competition to enter the market of 'small jobs' in Cameroon; and (iii) to prepare them for competitive national examinations such as the General Certificate of Education (G.C.E) and the Baccalaureate." (CGCE Board, 1994, p. iv). According to the university faculty, this is a big shift from the initial purpose of mathematics literacy on the eve of independence. He states:

> "The initial purpose, ...of the system of mathematics that persisted in this country was that brought by the British system which was meant to train people to be able to assist the administrators for taxation. So it was meant to assist government to be able to count and carry out numeric aspects of the administration. And that was emphasized in the curriculum i.e. numeracy was the main objective. This is not the case currently as the focus is on preparing students for national certificate examinations such as the G.C.E and the Baccalaureate with the hope that they will be able to study in foreign universities. The importance attached to these exams has impacted not only what is taught but how it is taught."

(2) To what extent has this purpose been served?

Following the three statements gleaned from the schemes of work as outlined above, it could be argued that there is some success with regard to statements (i) and (iii). As far as statement (ii) is concern, there is very little evidence of success as there are many Cameroonian graduates unable to gain employment with their mathematics education. Additional statements gleaned from yearly presidential addresses

to the nation have maintained that school mathematics should remain a compulsory subject in primary and secondary schools. What these proclamations fail to do is elaborate or provide some guidelines on what is meant by "compulsory" and exactly how the teaching (and learning) of mathematics will be carried out. The university faculty believes that government's failure in providing any guideline is only exacerbating the situation as far as mathematics education for development is concerned. He maintains,

> "Yes, government policy says mathematics is compulsory at all levels, in fact primary and first level of secondary education. And to make this compulsory nature meaningful to the students, it is one of the three subjects (the others being English and French languages) taken at all competitive exams. But outside that, you find students going to high school who never did mathematics. You find children successful who dropped mathematics in Form 2 (the second year of secondary school). So what really are we talking about compulsory? The notion of compulsory is pen and paper activity. It doesn't make sense.... However, the usefulness and the importance in real life is what have caused government to think that everybody should do mathematics. .... The question comes back: does school mathematics actually give the people the mathematics knowledge they need to survive? .... If we want to make school mathematics compulsory, it is necessary to completely overhaul the mathematics curriculum in Cameroon so that school mathematics should tie more to real life situations and people will see the usefulness."

(3) What flaws in the curriculum itself could have undermined its effectiveness?

The university faculty sees the adoption of alien curricula by Cameroonian educational authorities as one of the main reasons why the current school mathematics curriculum is suitable for producing individuals with the much-needed skills in the Cameroonian society. He points to the generation gap that has emerged as a result of the disconnection between the mathematics being taught in Cameroonian

schools today with the mathematics that was taught at the dawn of independence. He states,

> "...the big drift from past mathematical processes, what was taught, to the recent so called modern mathematics, creates a big gap between old generation and the new generation. And we need to bridge this gap by making mathematics that is interwoven. An old man who went through school in the 1960s should be able to pick up his grandson's arithmetic exercise book and say ok, o yeah, I looked at this. Where is your difficulty? But that linkage is not there."

(4) How could these flaws be eliminated and/or remedied?

The university faculty strongly believes in the need for educational reforms and not just curricula reforms. He is worried about the continued use of outdated curricula and the heavy reliance of the populace for employment from the government. He strongly believes a curriculum that caters to the need of Cameroonians by training them to become more self-reliant will bring about development. To this end, he sees the importance of developing a more responsive curriculum without relying on examinations to dictate what should be taught.

> "The West has moved away from this (modern mathematics) because if I look at the GCSE program in London, it caters more for the people there. But that's not what we are implementing here. We are still with the old curriculum of the 1960's from Britain, which is a shame. Every person who goes to school here is looking forward to having a white-collar job and this has proven to be very difficult. So this is a clear indication that we urgently need to reform, we need a reform; we need to change our entire educational system, the entire curriculum, to make it functional. As long as we are still thinking of competition, making our students go and study abroad, make sure that they have certificates that are recognized outside Cameroon, we will continue to teach this system that does not really cater for the development of Cameroon. This is one of the causes of unemployment, ... many people loitering around with degrees because the education they've acquired is not functional."

(5) What mathematics should be taught to Cameroonian children? Why?

The buzzword in his response to this question was "functionality". The need to develop and streamline the school mathematics curriculum that emphasizes critical and creative thinking, and raising the awareness of the presence of mathematical objects and practices in the daily lives of the students and within the immediate surroundings. He summed this up with the following statements:

> "But that is where we are faced with the need to streamline our school mathematics curriculum to the extent that people should be functional. Functional mathematics is what I would emphasize. And using mathematics to promote critical and creative thinking, and getting children to see mathematics as a language, a tool with its own aesthetic values that should be emphasized is crucial...To this end, a Cameroonian developed curriculum with a touch of local notions and applications ... will cause learners to not only see the relevance of the subject but to develop a liking for it. More meaning will also be given to real life mathematical concepts."

(a) How important are the following qualities when deciding on a mathematics text?

On a scale of 0 – 4 (0 = not important, 1 = slightly important, 2 = important, 3 = very important, 4 = crucial) all the five items were rated as either very important or crucial, with both 'correctness of content' and 'preparation for what the students would have to learn' being seen as crucial.

(b) To what extent would you agree or disagree with the following statements?

On a 5-point scale (0 = strongly disagree, 1 = disagree, 2 = neutral, 3 = agree, 4 = strongly agree), the university faculty strongly agreed that it was important for the mathematics curriculum to be seen by students as relevant to their future lives and therefore it was important for the mathematics curriculum to resonate as far as possible with the diverse home culture of the students. He equally agreed with the incorporation of cultural elements into the mathematics curriculum and making

mathematics real although this was not as highly rated as making it [mathematics] relevant to students' future lives.

5.2.4 Curriculum Reform Process

The process through which the curriculum of schools is designed and implemented is an important strategic concern in curriculum development theory because it has to do with the choice of the major arenas or locales where key decisions are made, the involvement of different categories of persons, the orchestration of material and other resources, and so forth. It can be said that the curriculum development process that is formulated or institutionalized in a school system at a specific time determines, to a large extent, the quality of the curriculum products and their dissemination or implementation. The curriculum development process in Cameroon utilizes top-down procedures and engages mainly persons who are in line or authority positions. Hence exploring the curriculum reform process from the point of view of the stakeholders is essential in understanding the requirements in bringing about successful curriculum change. Questions in this area therefore focused on the stakeholders' knowledge of curriculum reform, and curriculum development process in Cameroon with particular attention to mathematics. The three main questions were: (1) Who are those involved in the curriculum development and implementation process taking the case of school mathematics?, (2) Who are those involved in selecting official mathematics texts to use in secondary schools in Cameroon?, and (3) If you were to be charged with the responsibility of designing the mathematics curriculum for secondary schools in Cameroon, what are some of those things you would consider or pay attention to?

IV.1 The (limited) group

Questions in this area were intended to elicit the teachers', pedagogic adviser's and university faculty's knowledge of the curriculum reform process. The questions focused on the actual process and it was felt that students would lack the requisite knowledge and experience never having participated in the reform process. Knowledge of the curriculum reform process varied with each stakeholder (teacher, pedagogic adviser, and university faculty) and was indicative of his or her level of involvement in the reform process. The teachers professed limited knowledge while the university faculty and the pedagogic adviser expressed extensive knowledge of the whole reform process. This variation in the knowledge level relating to the curriculum reform process is not surprising. This is because curriculum reform in Cameroon is a top-down, centre-to-periphery model wherein the ministry personnel such as the national and provincial inspectors, pedagogic adviser, university expertise such as teacher educators, subject specialists and a very limited number of school teachers are invited to participate. Overall, only one in four teachers had some form of experience in curriculum reform while the pedagogic adviser and teacher educators had extensive experience in this process. This result is shown in Table 5.1.

Table 5.1: Experience in Curriculum Reform by Stakeholders

	No Experience	1 – 5 years Experience	6 – 10 years Experience	> 10 years Experience	Teaching Experience
Teacher A	X				15
Teacher B	X				12
Teacher K	X	X			22
Teacher N					12
Pedagogic Adviser		X			20
Teacher Educator				X	30

Table 5.1 does not include the students as they are usually excluded from participating in curriculum reform. The results seem to suggest that experience in curriculum reform is related to teaching experience. In other words, the longer a stakeholder has been teaching, the higher the chances of him/her being invited to participate in curriculum reform by the ministry of education.

IV.2 The teachers

Overall, the majority of teachers have little or no experience in curriculum reform matters. As a result, teacher's knowledge of curriculum development and innovation is very poor. Teachers' responses to the following questions seem to support this assertion:

(1) Who are those involved in curriculum reform process in Cameroon?

The system of government is very centralized and with the curriculum being considered a political document, the government through its ministry of national education strictly controls any changes to it. One reason for this control is because curriculum development has been limited to the writing of syllabuses in the traditional school subjects and to the requirements of examination systems such as the General Certificate of Education or the Baccalaureate. By controlling the reform process, the government hopes this will ensure quality control in the examinations.

> "The government, because there is an examination to be taken and then the government thinks that the way to measure the level of mathematics is by taking that examination. And so it is the government or the ministry of national education who does the planning of what goes into the curriculum document. When teachers are to be invited, the number is usually very insignificant." (Teacher K, CCC)

(2) Who are those involved in selecting official mathematics texts for use in secondary schools in Cameroon?

A crucial problem related to textbooks in Cameroon, is their selection. National inspectors and other higher educational authorities are required to recommend a list of textbooks for each school level on a yearly basis. Since the book market in Cameroon focuses essentially on students, both local and multi-national publishers are engaged in a cutthroat competition at the Central Office of the ministry of education for their books to be included in the annual national book list. Some of the teachers in this study expressed dismay in how this process of textbook selection is conducted:

> "In principle, it is the ministry of national education that selects the textbooks.... I think the teachers with the approval of the inspectors should be the ones to come out with the list of recommended text-books. ... But I know that what happens at times is that somebody writes a book and kind of finds out a way and before you know the book is on the list whereas the book may not be good." (Teacher A, CCAST)

> "It is the government or the ministry of national education. This is unfortunate that in Cameroon there are so many textbooks but they way the textbooks are recommended, it depends on who you are as the author or what I can say in quote 'pushing your way through to the person who would recommend them by giving him what he wants in order that the text should be there on the list. Not necessarily that the text is the required text or it is very, very important.'" (Teacher K, CCC)

> "The ministry does the selection of the official texts. But what many schools do is ask their teachers to suggest books which they think are good and then these books are added to the official list from the ministry." (Teacher N, CCAST)

(3) If you were to be charged with the responsibility of designing the mathematics curriculum for secondary schools in Cameroon, what are some of those things you would consider or pay attention to?

All the teachers were critical of the examination-focused nature of the curriculum and expressed the need for a responsive curriculum where examination is only one form of assessing success. The teachers believe that there is a need for the curriculum to include topics that facilitate the development of other non-academic life skills. Such skills are highly needed, they maintain, in a country like Cameroon whose economy is agricultural. Two of the teachers echoed the need for the curriculum to be reflective of current technological advancements. The following statements suggest their vision of the kind of curriculum needed in Cameroon:

> "I will try to include topics that would develop in the students, problem-solving skills especially problems encountered in their daily lives. Which means it should include topics which even if the student were not to continue with mathematics in the high school, they should be useful, that student should be useful; it should also be topics that would develop computation skills in the students; it should also be topics that would develop electronic skills if they have to get into the computer world they should have them even if the uses are not readily available. I would also like to include topics that would help them trace some cultural roots for some of the maths concepts such as modular arithmetic." (Teacher N, CCAST)

> "Just as the *slide rule* died off, I would wish that this *four figure tables* be thrown very far. Those are obsolete, but you still find teachers trying to bring out the idea of *four figure tables*. I would love to see that taken off because we are in the computer age, the computer has come and we don't need those things again. I think that is a major issue." (Teacher B, CCC)

> "We need to create a curriculum for people who are not going to continue to university. ... By extending topics like modular arithmetic to include various local counting systems, traditional calendars, and other local kinds of measurement would not only make mathematics

meaningful, but would be helpful to anyone who doesn't continue to university." (Teacher K, CCC)

Curriculum improvement in a school system is a continuous process that requires, among other things, frequent evaluation and analysis of strategy and issues related to that process. In the absence of such an effort, the curriculum may become increasingly less responsive to the needs of students and society. The above statements by the teachers suggest the need for a more responsive mathematics curriculum and the importance of constant reforms in curriculum development. The secondary school mathematics teachers were not alone in making the above suggestions. The pedagogic personnel and teacher educator equally made similar proposals.

IV.3 The Pedagogic Adviser and the University Faculty

These two stakeholders provided similar responses to questions focusing on the curriculum reform process. Their responses will therefore be presented together highlighting areas of agreement and areas of disagreement.

(1) Who are those involve in curriculum reform process in Cameroon?

In response to the above question, both the pedagogic adviser and the university faculty characterized the curriculum in Cameroon as a political document whose modification required an act of government. With the curriculum seen as a political document, it is no wonder why reforms to it would be viewed as the responsibility of the government through the Ministry of National Education. This control is illustrated in the following statements:

"That is the prerogative of the ministry of national education, they set up the structures to reform the curriculum and these structures usually begin with national inspectors, it will also involve the

provincial inspectors and other experts and resource persons." (Pedagogic Adviser)

Some of the experts and resource persons may be secondary school teachers but parents are rarely invited. The reason for not inviting parents was explained as follows:

> "You know that in Cameroon, not all parents will take an interest in the maths curriculum. Because, first of all, they are not very mathematically literate, and secondly it's a very centralized system which makes it very difficult to involve parents." (Pedagogic Adviser)

The above statements also suggest that Cameroon follows a centre-to-periphery model of curriculum development. This kind of curriculum development approach also referred to as 'top-down,' has made it difficult for teachers and parents to play a major role in the whole reform process.

(2) Who are those involved in selecting official mathematics texts for use in secondary schools in Cameroon?

When it comes to selection of textbooks for secondary schools, the ministry of national education also controls this with some input from a commission set up every year for that particular purpose. This centrality is intended to ensure uniformity in all the schools. But with most of the texts produced abroad, the situation degenerates into a situation of lobbying at the ministry wherein, texts are selected not because they are deemed good but because one author is able to lobby the ministry better than others. The university faculty is more direct in stating this:

> "...the ministry of national education decides on which textbook has to be used. It suffices for author X to write a book today on mathematics, sees a 'big gun' in the ministry and next year that book is in the booklist. Inclusion often not based on quality of the text but on the extent of lobbying."

(3) If you were to be charged with the responsibility of designing the mathematics curriculum for secondary schools in Cameroon, what are some of those things you would consider or pay attention to?

Designing an alternative mathematics program(s) for the various ability groups of students remains a constant demand by all those who should be participating in curriculum development. The pedagogic adviser views this as germane to providing a civic education and a mathematics education for self-reliant development. He maintains that providing a mathematics education that provide students with the technical skills needed in society and not mostly for proceeding to higher education which most families cannot afford at present is not serving the country well. He states:

> "Just like we have mathematics purely for engineers, we need to develop other curriculum areas that are tailored to particular trades. That way, students who are not able to proceed to university or just even high school can find employment with their mathematics skills. For example, we need to develop mathematics for weaving, bee keeping and conservation. These are useful curricular areas for us to develop." (Pedagogic Adviser)

The university faculty feels that the mathematics curriculum needs to illuminate and emphasize the relationship between school mathematics and real life mathematics. He sees this as important in providing a responsive mathematics education that can lead to self-reliant and self-sustainable development. He also sees this as one way of demystifying mathematics to the learners. He comments:

> "If I had a chance to work with the ministry of national education to prepare a mathematics curriculum for Cameroon secondary schools, my first plan would be to create a link between school mathematics and real life mathematics which would take into consideration the different backgrounds of our students. And to make sure that the student's initial knowledge of mathematics is not thrown away, as is in some other places, real life situations would need to be introduced in examination syllabuses. The examination should be able to assess or

> may be give projects to students who can carry these out and it would done on them that mathematics is not just addition, subtraction, regurgitating principles to teachers or the examination board." (University Faculty)

Also echoed is the need for the development of resource materials. The need for such materials could not be overstated considering the few numbers of mathematics teachers. These resources materials, the pedagogic adviser believes, will relieve teachers of the time often spent preparing their own individual materials.

(a) How important are the opinions of the following when deciding on an official mathematics text for secondary schools?

The ministry of national education and the national examination boards received the highest rating (were considered crucial) while the students and parents received the lowest. This response conveys the importance role the ministry of education and the examination boards play as far as curriculum reform decisions are concerned. The parents according to the pedagogic adviser play a less significant role because most parents are not mathematically literate. This view is also reinforced by the wide held assumption by some parents that such decisions are better kept in the hands of the government since it [the government] is supposed to know what is good for the students.

(b) How important are opinions of the following in the evaluation of student learning?

The response to this question ranged from 'important' to 'crucial' with the students and parents receiving the lowest rating. Again, the ministry of national education and the examination boards were rated as 'crucial'. It is interesting to note that the secondary teachers were rated as 'important' but not 'crucial' while the university faculty were rated as 'very important'. This response is indicative of the centralized nature of the educational system in which the decision process is often top-down.

On a 5-point scale ranging from 0 (not important) – 4 (crucial), the university faculty felt that the opinions of the ministry of education, national examination boards, university faculty, pedagogic adviser, secondary mathematics teachers, and parents were crucial in deciding on an official mathematics text, student evaluation, and curriculum content while that of the student was equally very important but not crucial.

From the foregoing presentation, it can be seen that the products of curriculum development in Cameroon are extremely limited. One reason for this paucity of curriculum materials is the tendency to centralize decision-making and, consequently, material and human resources at the centre, leaving the peripheral areas rather handicapped. There is therefore a need for investment in the production of curriculum material. To encourage this proliferation of curriculum development products, Tambo (2002) believes that "it would be necessary that authority be devolved on provincial and divisional educational authorities and adequate guidance, support and supervision provided from the Central Office in Yaounde so that different kinds of materials can be produced at different levels of the school system." (p. 162) This is important, considering that one practical way to improve curriculum practice in a school system is by introducing a variety of curriculum products that are valued by teachers, pupils and parents.

5.2.5 Importance of Formal Education

Broadly phrased questions on the importance of formal education were limited to the teachers, pedagogic adviser and university faculty while students responded to a more direct question on the importance of mathematics education. The teachers, pedagogic adviser and university faculty questions in this area were intended to elicit policy statements, and official aims, goals and objectives of formal education in general and it was thought that teachers, pedagogic adviser and

university faculty would have the requisite knowledge and experience to draw upon. So the teachers, pedagogic adviser, university faculty were asked during the interview, whether formal education is important to Cameroonians or not. If it is important, what role does school mathematics play in achieving the goals of educating Cameroonians? The exact phrasing of the questions were as follows: 'How important is formal education to Cameroonians?'; 'What role does mathematics education play in achieving the goals of educating Cameroonians in the 21st Century?'. These questions are important in developing a mathematics education for self-reliant development. This is because, non-formal education – education aimed at meeting societal needs such as the provision of skills in building trades, roads and bridge construction, farming, pottery, basketry, hunting, carving – is still cherished in many rural communities in Cameroon. This already flourishing kind of education will be useful in developing an ethnomathematics curriculum for secondary schools in Cameroon.

V.1 The whole group

All the teachers, pedagogic adviser, and university faculty stated that formal education was very important to Cameroonians especially as Cameroon is still a developing nation. Students also felt that mathematics education was very important especially as mathematics knowledge was required in any public professional examination. While there was total agreement on the importance of formal education to Cameroonians, there was however little consensus as to whether the kind of education currently practiced in Cameroon is actually helping Cameroon develop and become self-sustaining or remaining dependent on its formal colonial masters namely the French and the British.

V.2 The students

Which of the following is/are reason(s) for learning mathematics? (Circle all the reasons that apply to you.)

When asked about their reasons for learning mathematics, eight in ten students from both public and private secondary schools stated that they studied mathematics because it was useful in life and present in all public examinations. This was a consistent response in the first and second questionnaire. Responses increased from only one reason for studying mathematics to an average of two reasons for studying mathematics. Only one in five of those who stated that it was present in all public examinations also stated that they studied it because it was compulsory in school. Such a revelation brings the decision for making mathematics compulsory in secondary schools under question, as students clearly are not learning mathematics because it is compulsory but rather because they see its usefulness in life and presence in public examinations. The students' reasons were further strengthened by their response to the question on whether school mathematics should continue to be compulsory in secondary school:

> "It should be compulsory because it helps us in many things we do e.g. to calculate, count our money and so on. If you don't know any mathematics, you can be cheated when you are buying something." (Student, CCAST)

> "Mathematics should remain a compulsory subject in the secondary school because you cannot be a teacher or a mathematician without doing mathematics. And you cannot write any public exam without mathematics." (Student, CCC)

Statements like those above were common among students in both public and private schools and captured their reasons fro studying mathematics. The statement by the CCC student is more philosophical suggesting a view of what mathematics is when the student states that "you cannot be ... a mathematician

without doing mathematics". Such a view is evidence of already well formed notions of the nature of mathematics.

V.3 The teachers

(1) How important is formal education to Cameroonians?

All the teachers agreed on the importance of formal education to Cameroonians. There was a variation in terms of the kind of formal education being offered to Cameroonians because of the high number of unemployed graduates from high school and university. One of the teachers (Teacher N, CCAST), expressed disappointment with the fact that the government has been unable to articulate a clear policy for education. Another teacher (Teacher K, CCC) was of the opinion that the kind of formal education being offered is one geared towards white-collar jobs wherein every graduate is relying on the government to provide employment.

> "Education is quite important to Cameroonians and in fact to any human being. It makes you fit in the society and be able to communicate with the environment, and with the outside world. To have an understanding of what goes on in your country and beyond. As the world is being considered a global village, if you are not educated you will be left behind." (Teacher A, CCAST)

> "Very important. No country can develop if they are not serious about their educational policies. But sadly in Cameroon, there are no clearly stated policy statements as far as education is concern; only presidential or ministerial decrees governing how schools are to operate. But for what purpose, one doesn't really know." (Teacher N, CCAST)

> "Well, in Cameroon education is just for a white-collar job, it has never been considered as just being literate; learning to become literate. Just for a white-collar job or a job from which you can earn a salary." (Teacher K, CCC)

From the above statements, the teachers are suggesting the need for clearly articulated educational policy that would lead self-reliant development with the graduates being able to create employment for themselves without totally relying on the government. The above statements also point out the need for a reformulation of the goals of mathematics education geared towards self-reliant development, as we will see in their responses to the next question.

(2) What role does mathematics education play in achieving the goals of educating Cameroonians in the 21st Century?

In response to the question 'what role mathematics plays in the educational development of Cameroonians', the four teachers were unanimous in stating the importance of mathematics knowledge not just for formal education but also for the well being of mankind. These sentiments are well captured in the following excerpts:

> "Mathematics education is at the base of many if not all other fields. This is also true for the case of Cameroon where maths is not only compulsory as a government policy but on the programs of other fields as technical education, linguistics etc. In the francophone system of education NO student leaves secondary level to high school without a pass in mathematics because of the importance of the subject." (Teacher N, CCAST)

> "Because mathematics is applicable to various fields in society either consciously or unconsciously, the use of its principles as tools in fields such as physics, chemistry, engineering, biology, social studies etc is needed in the educational development of Cameroon. The statistical know-how and budgetary planning of the whole education system in Cameroon depends completely on mathematics education without which the entire system will crumble." (Teacher K, CCC)

> "We said mathematics is a language, it is a sharpener of the brain. So mathematics helps you to understand the sciences and the other humanities, it makes you to think logically. So it opens your brains to

> be able to think wisely. So the mathematics education will be able to help you to be able to fit into the society and be able to communicate with the outside world." (Teacher A, CCAST)

While all the teachers interviewed believe that mathematics education plays an important role in educating Cameroonians for the 21st century, one teacher was quick at pointing out how students believe they can still succeed with little or no mathematics education. Reasons for such believes go as such:

> "...if the purpose was to make every Cameroonian to be literate, and obviously mathematics would play a lot of role because people will be interested in learning mathematics because that is another aspect of literacy i.e. math literacy, and they will know many aspects about mathematics. But when you go now thinking of education as white-collar job, then people would now be trying to shy away from mathematics because if you were going to be a clerk in an office, you would need mathematics. But often, people would say let me just know how to type. That's all. He is not thinking of it as being something to help him properly communicate, do little things that can even help him but looking at it as doing something that can earn him something in terms of money. That's it. They don't see why a typist would need any mathematics." (Teacher K, CCC)

The above statements express the inappropriateness of the current school mathematics curriculum in Cameroon secondary schools and a need to redefine the goals of mathematics education. The articulation of such goals is needed for any reforms in mathematics to take place. The teachers are not alone in expressing the need for reform in mathematics education. The next section looks at the pedagogic adviser's responses to formal education and the role played by mathematics education in achieving educational development.

V.4 The pedagogic adviser

(1) How important is formal education to Cameroonians?

The pedagogic adviser believes that formal education has always been very important to Cameroon since the dawn of independence. He laments on the salaries being earned by educated Cameroonians and states that Cameroonians however are not encouraged to proceed further in education because of the low salaries those already educated are being paid. Clearly, he is suggesting that the drive for Cameroonians to acquire formal education is not commensurate with the rewards:

> "Everybody in the educational business agrees that education is very important. The problem is that salaries are very low in Cameroon, and that is not a very good motivator. The teachers in the field complain bitterly, they are doing a lot of work and the government says education is very important, but all teachers are paid very poorly when compared to police, gendarmes, the medical corps, and that tends to de-motivate very much because what an average teacher puts in is quite much but what he earns compared to the other professions is quite little." (Pedagogic Adviser)

(2) What role does mathematics education play in achieving the goals of educating Cameroonians in the 21st Century?

The pedagogic adviser sees mathematics as vital for educational development in Cameroon but laments the manner in which government policy (if any) towards education is being implemented. He points to the lack of direction on the part of the Cameroon government in ensuring that students are actually studying mathematics and do understand its uses in life. He explains:

> "Mathematics is a very important subject that mankind cannot afford to live without. Unlike other school subjects, I would say that any education devoid of a certain amount of mathematics will lead to very little development. The government realized that by making the

subject compulsory, but what is lacking is guidelines on how to ensure that students don't only see it as compulsory but are actually studying it in school."

The above statements suggest a common complaint given by teachers and university faculty alike regarding the government's decision in making mathematics compulsory. These complaints are based on the fact that while secondary mathematics is compulsory, there are no penalties for students who deliberately refuse to participate in mathematics lessons at the secondary and are able to proceed to university. The pedagogic adviser argues that just because a student is registered to write mathematics at the GCE does not mean that such a student is actually studying mathematics or at least sitting in during mathematics lessons. This is a recurring theme expressed by the participants regarding the status of school mathematics education in Cameroon.

V.5 The university faculty

(1) How important is formal education to Cameroonians?

The university faculty believes that the importance of formal education to Cameroon cannot be overstated. He is of the view that the main obstacle to formal education is the education itself. He maintains that the kind of education being carried out in Cameroon is borne out of a transplanted curriculum, which is alien to the masses and inappropriate to the present realities of Cameroon as a developing nation. He states:

> "Formal education, especially formal mathematics education is very important in the development of logical thinking and appreciation of roles. ... many of the African countries were becoming independent, they just went and picked those [European] curriculum packages, and got back home without asking questions whether they were suitable for their systems or not. They just transplanted them without any adaptation. So that is why our present educational system is really not

functional. We are still training people with the philosophy of the colonial masters."

(2) What role does mathematics education play in achieving the goals of educating Cameroonians in the 21st Century?

The university faculty sees mathematics education as essential for development of logical thinking and appreciation of roles. He cites the government decision for making school mathematics compulsory for secondary school as a realization, by the government, of the importance of mathematics education. What is not clear however, is how this compulsory nature is implemented in the school system. He therefore argues that the government may not need to make school mathematics compulsory if that mathematics education was made functional or more related to the immediate realities of Cameroonians. He explains:

> "If we had functional mathematics, definitely it will play a big role. ... school mathematics could use craft structures in our culture to improve on the nature of these crafts. If the man weaving his bags had made a loom this size, because he found when growing up as a child, his father had it that size, and he knows that he has so many fibres of thread to weave it and you take that to school and see how reducing the size, increasing the size, making it firmer, from a mathematical perspective you may find better designs. You may find that people will leave school not only with a mathematics certificate but will realize that, '...from my mathematical structure instead of counting three, if I count five, the same symmetry will be maintained instead of three.'"

The above statements suggest the pending need for a school mathematics curriculum that makes use of mathematical processes or concepts present in the daily cultural practices of Cameroonians.

5.2.6 Possibilities of an Ethnomathematics Curriculum

Questions in this last section were posed only to the teachers, university faculty and pedagogic adviser and were intended to elicit their knowledge and position on the possibilities of an ethnomathematics curriculum foundation.

VI.1 The whole group

Responses revealed that each respondent, to a certain degree, had a somewhat limited idea of what ethnomathematics was all about and that this view became broader later in the study. For example, the two teachers of the ethnomathematics unit attested to greater possibilities of an ethnomathematics curriculum for secondary schools compared to those who were involved with the non-ethnomathematics group of students. The pedagogic adviser and the university faculty were consistent in their response to the possibilities of an ethnomathematics curriculum. They all saw the benefits from such a curriculum pointed out certain things that will need to be in place before such a curriculum could be considered. Below are the respective responses of the teachers, pedagogic adviser and university faculty.

VI.2 Teachers

(1) What do you think ***ethnomathematics*** *means?*

The following statements suggest each teacher's refined understanding of what ethnomathematics is.

> "This means mathematics is part of man no matter his culture and is as old as creation. So there is a very close link between what we do and what primitive man did." (Teacher A, CCAST)

> "Math knowledge passed down orally from generation to generation within an indigenous community i.e. traditional maths used in different cultures in their daily activities which is not documented e.g. in weaving, sculpturing, thatching etc." (Teacher N, CCAST)

"Mathematics teaching based on the cultural background and its people or race. It may also be thought of as mathematics enculturation." (Teacher K, CCC)

"Mathematics derived as a result of the different tribes and cultures." (Teacher B, CCC)

In the first characterization is a historico-philosophical perspective locating mathematics knowledge and practice in human culture and suggesting the view that mathematics is a creation of mankind while the second characterization focuses on mathematics as undocumented knowledge passed from one generation to the other. This is a more conservative and restrictive view of mathematics suggesting that mathematics knowledge is not created but passed down from the elders to the youths. Such a view is characteristic of communal education that existed prior to formal education or colonialism.

The third view focuses on the teaching of mathematics and not on mathematics itself in describing what ethnomathematics *is* while the last view suggests that ethnomathematics is a collective for the different mathematics that exist as a result of the different world cultures. These varying views held by the teachers probably suggest their views about school mathematics and how it should be taught.

(2) How do you feel about an ethnomathematical foundation being incorporated into the mathematics curriculum for schools in Cameroon?

"Very good. This will spur the learner and objectives will be quickly attained." (Teacher A, CCAST)

"This would be very good, as some aspects of our culture would be highlighted, thus bringing math closer to the students. Poor results in math are sometimes associated with the foreign nature of the curriculum, hence an ethnomathematical foundation would build a sense of belonging in the students which would encourage more

learners in maths and hence a positive attitude towards maths." (Teacher N, CCAST)

"It will be a good idea because exposing mathematics by incorporating the cultural background will demystify mathematical mystic." (Teacher K, CCC)

"It will be a very good idea but it will be very difficult because Cameroon is made up of many ethnic groups." (Teacher B, CCC)

The above responses all favour the incorporation of an ethnomathematics curriculum foundation with the hope that it will lead to improved mathematics learning. While the first three statements demonstrate strong convictions by the teachers in stating the benefits that will accrue from implementing an ethnomathematics curriculum, the fourth statement suggests the potential for cultural conflicts in deciding what cultural practices to use as a source of knowledge for the curriculum given the numerous cultural groups in a country like Cameroon. This is an important concern that would need to be addressed before such a curriculum is developed and implemented.

(3) What sort of changes will need to be in place for such an ethnomathematical foundation to be implemented?

"It will require perfect bilingualism with a good panel of translators of textbooks. If possible in the long run, some of the national languages should be fused." (Teacher A, CCAST)

"It will require a change in the whole syllabus that teaching should be based on a syllabus developed from a curriculum rather than on an examination board oriented syllabus. As well, there should be in-service training of teachers in the new aspects to be introduced. Finally, objectives must be laid down based on the new philosophies of ethnomathematics education." (Teacher N, CCAST)

"No need for changes, but enforce some cultural aspects related to the various sections which need to. If it requires that we write in these, we can therefore introduce them in writing, in examples or in setting questions." (Teacher K, CCC)

"Some of the ethnic groups should be merged for such an ethno-mathematical foundation to be implemented which will still be very difficult because the different ethnic groups have different cultures and different languages." (Teacher B, CCC)

In general, all the teachers except one felt that there had to be certain changes in place for such a curriculum to be successful. The teacher who felt that there was no need for drastic changes suggests that inasmuch as cultural practices are incorporated to illustrate mathematical concepts it was equally important for those cultural aspects to be tested in the many exams the students will be writing. This is the reason given by all the teachers for not incorporating cultural connections of mathematics concepts because they are not being tested in the exams for which the students are preparing. The issue raised by one of the teachers is the difficulties of deciding on which culture to bring into the classroom given the huge numbers in the classroom. Addressing this issue will be the first requirement towards developing a mathematics curriculum for Cameroonian children.

(4) What effects will an ethnomathematical foundation to the curriculum have on national examinations like the G.C.E and Baccalaureate?

"There will be greater success in the examinations since this is a move from abstraction to being real/concrete." (Teacher A, CCAST)

"This will require them to re-examine their syllabuses to incorporate an 'ethno' part. It will employ them training new examiners. Financial effect i.e. cost of running the exams will rise." (Teacher N, CCAST)

"No effect because mathematical concepts are the same, for these concepts are found in our culture and we need to infuse in Western culture." (Teacher K, CCC)

"It could have a positive effect if the different cultures and dialects could be harmonized." (Teacher B, CCC)

All the teachers are attempting to articulate the benefits, as well as the costs, that will accrue from implementing an ethnomathematics curriculum. While some changes will first need to be in place, the benefits derived from an ethnomathematics curriculum will far outweigh the costs involve. Teachers are important agents for curriculum change and since the majority of the teachers above have expressed optimism for an ethnomathematics curriculum, it is now necessary to look at the other stakeholders who equally play an important role when it comes to curriculum reform in Cameroon.

VI.3 Pedagogic Adviser and the University Faculty

(1) What do you think ***ethnomathematics*** *means?*

"Relating mathematics to cultural values and showing the role of culture in mathematical settings." (University Faculty)

"Knowledge about the existence or evolution of mathematics concepts from any given human culture." (Pedagogic Adviser)

From the above statements, the university faculty is suggesting a more relational view of ethnomathematics while the pedagogic adviser defines ethnomathematics in more relativistic terms. While the university faculty's definition can be taken to mean relating formal school mathematics to cultural values, such a view does have implications for mathematics teaching. Similarly, the pedagogic adviser's definition has implications for both the nature of mathematics.

(2) How do you feel about an ethnomathematical foundation being incorporated into the mathematics curriculum for schools in Cameroon?

"It would be a very useful idea. In the North West, West and Northern provinces of Cameroon there are crafts that present tessellations and symmetries that could illustrate mathematical concepts." (University Faculty)

"I do think that every culture should be master of a certain type of mathematics depending entirely on the activity. It will help the student teachers realize how the different concepts, the different relationships, the different elements of mathematics evolved and how the relationships from certain cultures have lead to the development of mathematical ideas." (Pedagogic Adviser)

The university faculty and the pedagogic adviser both express optimism for an ethnomathematics curriculum. The university faculty points to the immediate benefits from such a curriculum, the pedagogic adviser focuses on the changes and benefits that will follow in the teacher education program – an aspect of curriculum reform that is yet the get the attention of the Cameroon government.

(3) What sort of changes will need to be in place for such an ethnomathematical foundation to be implemented?

"A working session with mathematics teachers, examination boards and the ministry of education." (University Faculty)

"Well, it would depend entirely on how the mathematics program is structured. It could be that there is a mathematics program in which cultural practices are irrelevant in developing some concepts. The ministry will need to organize a curriculum forum like the one in 1995, inviting some teachers." (Pedagogic Adviser)

The pedagogic adviser and university faculty both agree that all the major stakeholders will need to be involved in the development and implementation of the

curriculum. This is vital for successful curriculum change given that the ministry of education has the tradition of organizing curriculum forums without inviting all the major stakeholders, including parents and students.

(4) What effects will an ethnomathematical foundation to the curriculum have on national examinations like the G.C.E and Baccalaureate?

"Examination questions may have more relevance to students since they will find local samples to relate their mathematical ideas to."

"Examination questions will be more realistic and students will come to view mathematics as part of their culture."

The pedagogic adviser and university faculty both agree that there will be more benefits to the students and to the kind of mathematics education offered, as students will be able to relate to what they are learning.

The above statements suggest the pending need for a school mathematics curriculum that makes use of mathematical processes and concepts present in the daily cultural practices of Cameroonians.

5.3 Summary

1. Generally, the stakeholders held multiple views regarding the nature of mathematics, images that ranged from mathematics as a language, mathematics as a science, mathematics as pre-given (not created) knowledge, and mathematics as a mind developer. Although the majority of the stakeholders believed that mathematical problems could be solved in many different ways, many of them still viewed mathematics as a science or collection of rules and procedures.

2. All the stakeholders ascribed to the view that school mathematics has a cultural connection. Most students in both the public and private schools felt that

mathematics was present in their culture although the word mathematics was never uttered. The students were also quick to point out that the mathematics, which they learned in school, was more complicated than the one used in their culture, which is mainly for counting. While all the teachers acknowledged that there was an important existing connection between school mathematics and the local culture, only two of them presented a historical and cultural approach sometimes in their teaching of mathematics. All the teachers, university faculty and pedagogic adviser stated that the limited number of mathematics teachers for secondary schools was a major reason why such curricular sources would be ignored or overlooked given the time constrains and the overloaded timetables.

3. The majority of the students expressed the need for a multi-method approach to problem solving as a way of debunking the view of mathematics as an 'exact science' or even demystifying mathematics altogether. A majority of the students also preferred that school mathematics remain compulsory. There was however, a general consensus among three of the teachers, university faculty and pedagogic adviser that the school mathematics currently being offered to Cameroonian children is a product of colonialism. They suggested that a way forward in mathematics education for Cameroonian secondary schools would require major curriculum reforms with a focus on self-reliance and self-sustainability.

4. The respondents agreed that formal education was an indispensable key to personal and social improvement and that a sound basic education is fundamental to self-reliant development. They equally lamented on the fact that Cameroon was still following the educational system set up during colonialism. The teachers, university faculty and pedagogic adviser all view this kind of education as inappropriate as they concurred with Rodney's (1989) statement that "...It is not an educational system designed to give young people confidence and pride as members of African society, but

one which seeks to instil a sense of deference towards all that is European and capitalist." (Rodney, cited in Azevedo, 1989, p. 140)

5. The stakeholders with the exception of a few students agreed that school mathematics is important and its importance was viewed as closely related to its utilitarian aspect, but less so for an appreciation of its societal and cultural values. However, the view that mathematics is important merely for its utilitarian aspect was most strongly expressed by the teachers and students. All the stakeholders with the exception of the students felt that there was an urgent need to carry out curricular reforms in mathematics.

6. Generally, there was an expressed positive response and willingness to try the ethnomathematics foundation curriculum. The stakeholders held varying views about their understanding of what ethnomathematics is. With these later refined views, all the teachers expressed the need for a more responsive mathematics curriculum. They also acknowledge that such changes in the curriculum will affect not only the content and process of mathematics teaching and learning but of the evaluation of learning in general. As a result the certificate examinations like the GCE will need to be reformed to reflect the changes in the curriculum.

5.4 Conclusion

In concluding, this chapter presented the findings of the study from data collected through questionnaires and semi-structured interview. All the stakeholders express the need for an appropriate mathematics education and believe that in a country like Cameroon with a rich cultural heritage, an ethnomathematics curriculum foundation will be responsive to the needs of Cameroonians in their drive for self-reliance development. In addition, several of the stakeholders especially students stressed the importance of relating mathematics to daily life experiences or activities and teaching it as a practical tool. They also suggested that

as an effective teaching strategy, students should be allowed to explore and solve problems themselves. Also highlighted were areas of concern or caution in developing and implementing an ethnomathematical curriculum foundation. The next section analyzes and discusses the findings and provides some possible implications for mathematics education.

Chapter 6

ANALYSIS OF FINDINGS

6.1 Introduction

The aim of this study was not to present generalizations that could be taken as completely dependable. Rather, focus was on assessing the stakeholders' receptiveness to an ethnomathematics curriculum foundation. Therefore, it is important to acknowledge here that the overall findings of this study are limited in generalizability and representativeness. This is not a weakness but an important characteristic of case study research. As outlined in Chapter 4, the research sites were selected because they were viewed as interesting by the researcher and the participants were chosen because they volunteered to participate in the study. Hence, all the findings discussed in this chapter for these reasons must be interpreted with caution.

In Chapter 5, I presented the findings based on the data collected using questionnaires and semi-structure interviews. In this chapter, I will attempt to synthesize the data in order to build a coherent picture of the stakeholders' interests and response to the ethnomathematics curriculum foundation. It appears that there are some differences in views about ethnomathematics emerging from these analyses. Also apparent in the analyses is the emergence of commonalities and differences in levels of interests expressed by the stakeholders. In addition, there are some significant differences in the levels of concerns in implementing an ethnomathematics curriculum foundation among the stakeholders. The discussion of these emerging views and levels of interests (and concern) is essential in providing foundational guidelines for mathematics education reform in Cameroon.

6.2 Stakeholders' Perceptions of an Ethnomathematics Curriculum

Questions eliciting the perception of an ethnomathematics curriculum were limited to the teachers, pedagogic adviser and university faculty. The perceptions of an ethnomathematics curriculum held by the teachers, pedagogic adviser and university faculty were influenced by their views of what mathematics *is* as well as their knowledge of the concept of the curriculum. The findings showed that the teachers, pedagogic adviser and university faculty held varied but limited views or notions of what a curriculum is. This is partly because in Cameroon, curriculum authorities have ascribed to a definition that limits the curriculum and curriculum development to the writing of syllabuses in the traditional school subjects and to the requirements of examination systems such as the General Certificate of Education or the Baccalaureate. Another reason for this limited view of the concept of curriculum could be attributed to the fact that the teachers, after graduating from teacher training institutions and schools of education are handed a syllabus (GCE or Baccalaureate), which is simply a list of topics to be completed in preparation for the GCE or Baccalaureate.

6.2.1 The (limited) group

Findings from both the quantitative and qualitative data suggest that the stakeholders' (students excluded) images of mathematics and teaching/learning mathematics appear similar, and overlap with each other. Thus, in the following sections, images of learning mathematics will be subsumed into the category of images of mathematics and discussed as such.

Stakeholders' (students excluded) responses to the question 'What does mathematics mean to you?' suggest that they did not differentiate between images of mathematics in terms of the nature of mathematics and of teaching/learning mathematics. Indirectly, the findings suggest that these stakeholders' (students excluded) images of mathematics might have been derived from their experiences of learning

and teaching mathematics. The inability of the teachers, pedagogic adviser and university faculty to differentiate their images is not surprising. Kelly and Oldham (1992) observed similar results among primary teachers and student teachers who could not differentiate their views about mathematics from their views about mathematics education. In brief, these findings suggest that the views expressed by this group of stakeholders (teachers, pedagogic adviser and university faculty) are very likely to be closely linked to mathematics and mathematics learning experience.

The images held by the teachers, pedagogic adviser, and university faculty were not unique to each but overlapped. In most cases, the respondents held more than one image of mathematics. The fact that each of the above respondents held more than one view of mathematics suggests that their image of mathematics was not limited to school mathematics alone but included everyday mathematics, street mathematics, pure mathematics, applied mathematics or simply numeracy. The meaning of mathematics was sometimes couched in metaphoric language. Examples included mathematics as a *cultural artifact*, mathematics as a *tool*, and mathematics as a *language*. The views held by the two teachers (Teacher A, CCAST & Teacher K, CCC) who actually taught the ethnomathematics unit held similar views to the other two teachers (Teacher N, CCAST & Teacher B, CCC). Most respondents held a *utilitarian view* of mathematics by focusing on its practical value in everyday life. For example, "develops logical thinking" (Teacher A, CCAST). Others held a *symbolic view* of mathematics by characterizing it as a collection of numbers or symbols. For example, "is a quantifier, a science of numbers" (Teacher K, CCC). Still, others held a *problem solving view* of mathematics by seeing it as a set of problems to be solved. For example, "the logical use of numbers and shapes involving calculations" (Teacher B, CCC). The fourth view held by a few of the respondents was the *absolutist view* i.e. mathematics is a certain and unquestionable set of truths. For example, mathematics is "thought provoking, ...follows certain principles" (University Faculty). According to Ernest (1991), an absolutist view of mathematics is characterised by mathematics

consisting of a set of absolute and unquestionable truth. In addition, mathematical truth is exact and certain, while mathematical knowledge is objective, value-free and culture-free. In contrast, the fallibilist view of mathematics is characterised by "mathematical truth as fallible and corrigible, and can never be regarded as beyond revision and correction" (Ernest, 1991, p. 18). This philosophical debate is indispensable since teaching and learning mathematics is influenced by the perspective adopted, and because mathematics has had such a central role in the advancement of societies that defining its nature, role and methodology has become a central, ideological and cultural issue. In all, the *utilitarian view* and the *symbolic view* were the two most commonly shared views while the *absolutist view* was the least common among these views that seem to recur in this study.

This suggests that this limited group of stakeholders (teachers, pedagogic adviser and university faculty) were able to hold many images and views about mathematics at the same time. FitzSimons and colleagues (1996) caution about assuming the heterogeneity in the meanings of the term 'mathematics'. The stakeholders' (students excluded) views of mathematics shaped their perceptions of what ethnomathematics is. Table 6.1 below presents the views held by the limited group of stakeholders about the nature of mathematics and ethnomathematics.

Table 6.1: Stakeholders' Views of Mathematics and Ethnomathematics

Stakeholders	Views of Mathematics	Perceptions of Ethnomathematics
Teacher A, CCAST	Is a language of the sciences, develops logical thinking; Is a cultural artifact, history is important; Is utilitarian, sharpens the brains.	This means mathematics is part of man no matter his culture and is as old as creation. So there is a very close link between what we do and what primitive man did.
Teacher N, CCAST	Is the science of numbers, builds up logical thinking; It involves the building up of theories which serve as framework in various fields e.g. binary theory in computer programs etc.	Math knowledge passed down orally from generation to generation within an indigenous community i.e. traditional maths used in different cultures in their daily activities which is not documented e.g. in weaving, sculpturing, thatching etc.
Teacher K, CCC	Is a quantifier; Science which involves logical study of shapes, arrangement, quantity, and many related concepts and may fall into the following branches: arithmetic, algebra, analysis, geometry, trigonometry etc; Is continuously evolving; It is history,	Mathematics teaching based on the cultural background and its people or race. It may also be thought of as mathematics enculturation.
Teacher B, CCC	Is a logical use of numbers and shapes involving calculations.	Mathematics derived as a result of the different tribes and cultures.
Pedagogic Adviser	Is a language, a way of expression; It is Human creation; It is culturally bound and not pre-given knowledge; It is not static.	Mathematics practiced in a particular culture. It varies from culture to culture
University Faculty	Science of symbols; Is a language, tool, a way of reasoning; Is dynamic, developed from practical situations, not pre-given knowledge; Human creation not God made; Thought provoking, follows certain principles; History is important.	Relating mathematics to cultural values and showing the role of culture in mathematical settings.

6.2.2 Teachers

While teachers held different views of what mathematics is, the results reveal that these views did not affect their views on the purpose of mathematics education as all the teachers held similar perceptions of the purpose of mathematics education in the case of Cameroon. Each teacher's judgment of the ethnomathematical curriculum foundation was influenced by what seemed to be most compatible with

their views of teaching, and what they identified as major dilemmas in teaching. The usefulness of a curriculum was determined based on the extent to which it assisted the teachers in resolving those dilemmas (see Manouchehri & Goodman, 2000 for more on teachers' dilemmas in implementing curriculum change).

Of the 4 teachers who participated in this study, two (one from CCAST Bambili and one from CCC Mankon) did not expect students to know mathematics which they were not explicitly taught. According to the perspective of Teacher N in CCAST, learning mathematics required explicit exposure to the mathematics. In the following quote, Teacher N, emphasizes the importance of the teacher in the learning process.

> Because a lot of knowledge is built up when a topic is taught in class or even read by a learner (in the case of out of class study by learner). Though this might involve from the students some remote knowledge of that particular maths, it is usually better understood only when there is an instructor to guide them. (Teacher N, CCAST)

The suggestion from the above statement by Teacher N is that a student may have awareness, but not know an idea, from just one exposure. Teacher N's view of mathematics learning suggests her perception of an ethnomathematics education where the teacher plays the major role of a guide in raising the students' awareness of mathematics concepts in their everyday social contexts. This view of learning is in keeping with Vygotsky's Zone of Proximal Development (Vygotsky, 1978), where performance is assisted by others who are more capable. The [mathematics] educational implication for such a perception is that teachers need to have a sound knowledge of the presence of mathematical concepts and processes in cultural and everyday practices and skills in how to mediate the students learning. From this standpoint, "it is reasonable to treat learning as primarily a process of enculturation, and to emphasize the crucial role played by both children's interactions with more

knowledgeable others and their mastery of tools that are specific to the culture" (Cobb, 1995, p. 123).

In response to the question 'What do you think ethnomathematics means?', Teacher N, in CCAST, held a more informal perception by stating that ethnomathematics is "Math knowledge passed down orally from generation to generation within an indigenous community i.e. traditional maths used in different cultures in their daily activities which is not documented e.g. in weaving, sculpturing, thatching etc." This view suggests history and culture as important tenets of ethnomathematics. Teacher N, is also suggesting that there is a distinction between school mathematics and ethnomathematics by labeling it as *traditional maths*. Also implicit in this characterization of ethnomathematics as 'math knowledge passed down orally' is the idea that ethnomathematics is mathematics knowledge found in primitive or non-literate societies.

The teachers' views of what mathematics is have philosophical and psychological underpinnings of their teaching and learning of mathematics and consequently on their conception of ethnomathematics.

6.2.3 Pedagogic Adviser

The pedagogic adviser used the following in describing what mathematics is:

> "Is a language, a way of expression, is culturally-bound, not pre-given knowledge, human creation, not static. It is linked to man's culture, knowing is influenced by the culture of the knower, and history is germane."

He believed that every mathematical element is traceable to some cultural origins. This view of mathematics as possessing cultural origins concurs with the central tenets of ethnomathematics that mathematics is a cultural product. While he believed that mathematics arose out of cultural practices, he however argued that one couldn't create mathematics simply by reflecting on mathematics but by using

mathematics. It is therefore not surprising when he defines ethnomathematics as "Mathematics practiced in a particular culture and varies from culture to culture."

6.2.4 *University Faculty*

In describing what mathematics means, the University Faculty used the following:

> Science of symbols; Is a language, tool, way of reasoning; Is dynamic, developed from practical situations, not pre-given knowledge; Human creation not God made; Thought provoking, follows certain principles; History is important, Nomenclature is part of its aesthetics.

The above descriptions suggest that the university faculty held many images or views of mathematics. By stating that mathematics is a language, human creation and not God made, he is suggesting a cultural connection with mathematics since language is part of human culture. His descriptions also suggest a more fallibilist view of mathematics by stating that it is not God made. The existence of the kind of diversity represented in the above descriptions leads one to expect that a range of different views or beliefs exists across the discipline as a whole. It could be said that these beliefs are held within a philosophical position, which Restivo (1999) has called "transcendental" although, at the same time, he points out that even the transcendental is a human construction:

> "Truth and knowledge, as fallible and tentative achievements, are manufactured by human beings who accomplish what they know and what they can know in common."(Restivo, 1999, p. 4)

Definition of Ethnomathematics

> Ethnomathematics means "Relating mathematics to cultural values and showing the role of culture in mathematical settings".

By defining ethnomathematics this way, the university faculty is suggesting that mathematics is not culture-free but rather culture-bound i.e. the kind of mathematics in any given society is influenced as much by the cultural demands of that society as by the interaction of that culture with a foreign culture. It is therefore reasonable to suggest from his definition that ethnomathematics is not static but dynamic. What remains to be seen is whether the above definition and characterizations influence the level of interest in an ethnomathematics curriculum foundation.

6.2.5 Summary

The teachers, pedagogic adviser and university faculty each held a limited view of the concept of the curriculum and this view seemed to have partly influenced their individual perceptions of an ethnomathematics curriculum foundation. Their various images of mathematics were another source of influence on their perception of ethnomathematics and of an ethnomathematical curriculum. The views held by the two teachers (Teacher A, CCAST & Teacher K, CCC) who actually taught the ethnomathematics unit were not different from those held by the other two teachers (Teacher N, CCAST & Teacher B, CCC), the pedagogic adviser and the university faculty. The respondents' perception of ethnomathematics could be summed up as "relating mathematics to culture and showing the role of culture in mathematics." Whether this somewhat limited perception of ethnomathematics influenced their level of support for or interest in an ethnomathematics curriculum remains to be seen. But the main aim of this thesis has been to assess and understand the stakeholders' interests and response to an ethnomathematics curriculum foundation with the hope that such understanding will be helpful in eventually developing, adopting and implementing such a curriculum in Cameroon. In the next section, I endeavour to analyze the statements made by the stakeholders that seem to indicate their level of support for or interest in an ethnomathematics curriculum.

6.3 Stakeholders' Levels of Interests towards an Ethnomathematics Curriculum

6.3.1 The whole group

In spite of the traditional education of the Anglophone Cameroon, and the requirement for students in the fifth and seventh year of secondary school to sit for examinations modelled after the British system of education, the ethnomathematics curriculum foundation was understood and welcomed by a majority of the stake-holders. Their levels of interests varied in how they viewed the importance of the school curriculum to be congruous with local ways of thinking and ways of life, in both content and methods.

6.3.2 Students

The interest generated by the ethnomathematics unit activities among the students in both schools was overwhelming. The immense possibilities of what could be achieved in a mathematics-learning situation by incorporating culturally relevant experiences, common everyday materials, events, and artifacts in the locality, seemed to enliven and empower the students mathematically, socially and epistemologically in this study. Mathematically, the students felt that they acquired some level of power over the language, symbols, knowledge and skills of mathematics and the ability to confidently apply this in mathematical applications within the context of schooling, and possibly to a lesser extent, outside of this context. The enthusiasm and promptness with which the students volunteered to participate in classroom activities, the extent to which the students were able to explain the rules (of each game) involved in many of the selected everyday activities containing mathematics concepts and processes, the vivacity with which they identified mathematical processes present in each game and the strategies for winning or losing were eloquent testimonies that the ethnomathematics unit activities struck a chord. The students felt happy to be operating on familiar, home turf. It seemed that

the students suddenly discovered that mathematics is, after all, part and parcel of their everyday life, that it is a familiar, close-to-home subject, not a far-off foreign invention. Each student's personal engagement with mathematics so that it [mathematics] became an integral part of his or her personal identity can lead to what Ernest (March 2002) has described as "epistemological empowerment" (p. 2). This epistemological empowerment wherein the student experiences growth in confidence not only in using mathematics, but also a personal sense of power over the creation and validation of knowledge is essential for success in mathematics education.

6.3.3 Teachers

Despite the very positive reception of the teachers towards incorporating relevant cultural practices containing mathematical illustrations in their teaching, it was more often the case that teachers' efforts sought to foster cultural connections by orchestrating activities where cultural information could be presented to students through traditional approaches to teaching mathematics.

Teachers' perceptions of what mathematics is, what is important about mathematics in general or about the mathematics in the ethnomathematics sample unit affected their choices of tasks, the ways in which they followed up on student responses, their assessment of student understanding and consequently their level of interest in an ethnomathematics curriculum foundation.

Interest related to Content

A fundamental aspect of the pedagogical philosophy of an ethnomathematics curriculum is that teachers use the informal mathematics knowledge and relevant cultural experiences that children bring into the classroom. Teachers of this type of curriculum will therefore need to be well aware of children's knowledge and experiences to use it as a starting point from which to build. For some of the teachers

in this study, the idea of building on students' informal mathematics knowledge was already integral to their own concept of good teaching. To others, this idea was understood mainly in theory than in their daily pedagogical practice partly because of the class size. All the teachers however agreed that students come to school with a rich store of cultural and experiential knowledge, talents, and strength and that these are foundation for further learning. As one of the teachers stated:

> "...when you make reference to it, to what they know at home, it helps their understanding of the formal maths that you are teaching them in class. Children have observed their parents at work constructing houses and so on, and these parents have never been to formal schools and yet they do construction... So they employ a lot of geometry. So when you come to teach geometry in class you have to make reference to that. That arouses their interest and they understand very quickly what you are doing." (Teacher A, CCAST)

The knowledge that children bring with them to school has a powerful influence on how they interpret and learn the mathematics taught in school. Evidence indicates that programs such as Cognitively Guided Instruction (Fennema, Carpenter, & Lamon, 1991) that assist teachers to build on children's informal knowledge, help "children use their intellect well, make meaning out of mathematical situations, learn mathematics with understanding, and connect their informal knowledge to school mathematics" (Gutstein et al., 1997, p. 711). Valuing and building on children's informal mathematics knowledge is at the heart of an ethnomathematics pedagogy.

It is possible that there will be cultural variations in the children's mathematical activities outside of school. Studying how children use mathematics in their everyday activities outside of school is important for educational practice. In order to build on the informal understandings and attitudes about mathematics that children bring with them to school, teachers would need to understand and value children's everyday mathematical activities and the informal mathematics knowledge

acquired in them (Fuson, Zecker, Lo Cicero, & Pilar, 1995; Sleeter, 1997; Tate, 1997). Everyday activities may serve as models for classroom-based instruction that builds on children's natural motivation and helps students to see the real-world application of the mathematics taught in school (Fuson et al., 1995).

Interest related to Process

The interests expressed by the teachers' in relation to the process of learning and teaching mathematics centred on relevance in the mathematical processes that students are currently learning which they viewed as not responding to the realities of the Cameroonian society. They see an ethnomathematics curriculum as helping to (i) demystify mathematics, (ii) debunking the widely held view that mathematics is all about looking for the right answer to a textbook problem. They see Cameroonian games as a fertile area to explore with the students some mathematical concepts which seem abstract to the students in the classroom. As one of the teachers put it:

> "Yes, I would find some aspects of it to be included because when you know how it developed, you put more interest into it. It's like a base, it forms the basis of it though you would be dealing with the modern times of the mathematics, you would know that it started from this. You would have less difficulty with this modern one because you are starting where those people who started it did, say from first principle." (Teacher N, CCAST)

One of the teachers noted that an ethnomathematics curriculum was already having an effect in his classroom as there was a noticeable spike in the students' interests, a classroom atmosphere which he had only experienced during the first week of the school year. He explains:

> "My impression is that this new approach helps the students see the direct application of what they are learning in class, which is good. And the students seem to be enjoying it because the class is livelier. (Fieldnotes with Teacher A, CCAST)

What the teacher is saying here goes right to the heart of an ethnomathematics praxis that according to Powell and Frankenstein (1997b) arises out of "investigating the ethnomathematics of a culture to construct curricula with people from that culture" (p. 249).

Besides its potential pedagogic benefits and challenges, the most powerful reason for introducing games into the mathematics classroom is probably the enthusiasm, excitement and total involvement and enjoyment that many children experience when playing games. As Ernest (1986) notes, "pupils become strongly motivated, they immerse themselves in the activity, and over a period of time should enhance their attitude towards the subject" (p. 2). Games are played in a context in which there is usually help available, Hatch (1998) found that groups are usually supportive of each other, solving problems for people who are stuck and offering effective peer tuition. Kirkby (1992) too notes the need for pupils to experience success, satisfaction, self-confidence, enjoyment, excitement, enthusiasm, interest and active involvement. He believes that there is "no medium more powerful for providing these experiences than the use of games" (p. 5). Children playing a mathematical game against each other co-operate playing the game and if they play in teams they quickly learn that to play effectively they must co-operate. Thus playing games provides an opportunity for children to *work co-operatively*. Some mathematical games provide the opportunity for students to *make predictions*. Using mathematical games helps learners *develop their mental ability*. As Hatch (1998) observes, "one does not record anything while playing a game unless one has to. Players seem readily to accept that when playing a game a calculator is not normally used; indeed, it often slows the game unacceptably" (p. 6).

It is not surprising that teachers are interested in an ethnomathematics curriculum because the curriculum contained mathematical concepts present in Cameroonian games (see Appendix B for sample mathematics games). Whether this

interest in ethnomathematics will transfer to an interest in learning and developing other ethnomathematics such as academic mathematics is not known.

Interests related to Methodology

The teachers believe that it would be naïve to have an ethnomathematics curriculum if the learning derived from such a curriculum does not help the immediate society in attending to everyday realities.

> "... the curriculum for mathematics must be in line with those kinds of things. Because it must put into play the kind of views in mathematics that we think would fit our own environment. It must be such that it would be useful to us despite the fact that you must go into the beauty of it quite all right, but it should be such that you'll be able to use it in your own environment. So it must tie up now with the culture of that country." (Teacher B, CCAST)

Teacher training courses and programs would need to include courses on culture, society, and history of the evolution of mathematical concepts. As Fasheh (1997) maintains, "no change in mathematics curriculum is effective unless the teachers understand the change in all its dimension" (p. 288).

6.3.4 Pedagogic Adviser

The pedagogic adviser's overall response to the ethnomathematics curriculum was captured in the following declaration:

> "For the very least, a culture-aware mathematics curriculum would make a significant contribution to raising levels of interest and achievement in mathematics."

He expressed his interest in an ethnomathematics curriculum in terms of what he saw as potential benefits of implementing an ethnomathematics curriculum foundation. These benefits are classified into three main areas: relevance to content, process and methodology.

Interest related to Content

The pedagogic adviser sees an ethnomathematics curriculum foundation as actually adhering to the official educational policy which specifies that all education in Cameroon should aim at "reviving the Cameroonian culture" and at "re-establishing a Cameroonian personality" (MINEDUC, 1984). In the area of content, it is true that some tribes in Cameroon have counting systems different from base ten which could be used to enhance the teaching/learning of bases other than ten. The pedagogic adviser cites the following examples as relevant content which an ethno-mathematics curriculum would identify and incorporate:

> "Most cultures in Cameroon have an 8-day week and the year in most cultures has 13 'traditional' months: these aspects would be suitable in the mathematics curriculum as examples of modular arithmetic and group systems."

The pedagogic adviser's strong convictions about the importance of cultural relevance in the mathematics content are in line with his views about the origins of mathematics. This is expressed in the following excerpts:

> "Every mathematical element can be traceable to one cultural element in one form or the other... So I think that history is important. It is very important for us to know how some of these elements originated. We will appreciate them better and we will easily tie them to their cultural background, when we are explaining them especially to learners."

Another example to illustrate his point can be found in the very lives of Cameroonians that are conditioned on a daily basis by fortune-tellers, rain-doctors, and sorcerers who for their practice use cowries, kola-nut shells, etc. to predict and foretell. The practice of these traditional diviners may conceal fundamental concepts of probably and chance and are more culturally relevant than the coin-tossing and dice throwing. Many Cameroonian children have experienced cultural practices and

would be able to relate to the mathematical concepts and even provide alternative explanations for a particular outcome when a set of cowries is tossed. The incorporation of these relevant cultural practices could lead to the development of a Cameroonian-oriented philosophy of mathematics and of mathematics education.

Including ethnomathematics in the arts would allow mathematics teachers who would like to include ethnomathematics components in their teaching to refer to examples that the students are already engaged with, and would provide art teachers with new tools for design and analysis. Similar advantages could be obtained in other disciplines.

Interest related to Process

A significant feature of learning mathematics is the ability to think through a problem and to make logical deductions. For young children, logical or analytical abstraction is preceded by concrete or physical experiences and by the observation of patterns (from which deductions can be made). Observed variations in mathematical performance in different contexts such as 'school' and 'everyday' situations have suggested that it is the environment in which the mathematics takes place, not the problem to which it is applied, which determines the selection of the mathematical procedure. If the child has no concrete experiences which can bridge the gap between the home culture and the culture of mathematics, the child's ability to conceptualize would be limited. The pedagogic adviser therefore believes that an ethnomathematics curriculum foundation would emphasize culture as central to mathematics learning. As the following excerpts illustrate:

> "Well, from the definition of mathematics, we say mathematics is a way of expression. Any way of expression is culturally bound. The way one expresses oneself depends on one's culture. And the way one approximates, one reasons, one calculates, is culturally bound. And if mathematics develops from this, then you cannot divorce it from culture."

He believes that by making culture central to mathematics learning, teachers would begin to identify concrete experiences in the students' local environment and this awareness is crucial for success in mathematics as everyday practices.

Interest related to Methodology

Because the pedagogic adviser had just begun to promote the importance of relating mathematics instructions to the children's relevant cultural experiences, his interests in relation to methodology were more actualized than situational. This is because he did not only view an ethnomathematics curriculum foundation as interesting, but felt that it was essential and he was willing to support this type of curriculum. He was quick at identifying immediate methodological benefits that would accrue from such a curriculum in the areas of group work, discovery learning, and didactic materials such as textbooks. He felt that an ethnomathematics curriculum foundation would be essential in rendering methodological perspectives that are culturally relevant such as group work in the mathematics classroom. Such a perspective is viewed as relevant in the Cameroonian context because Cameroonian culture stresses communality, co-operation and sharing. People tend to assist each other and expect to be assisted by others when in difficulties. It is therefore possible to see why he would be interested in an ethnomathematics curriculum foundation because the current mathematics curriculum, on the other hand, by their schemes of individualized assessment, stress individuality, competition and rivalry. The pedagogic adviser is clearly suggesting the importance of a culturally relevant approach to the assessment of learning in the ethnomathematics curriculum foundation. He cites the current mathematics curriculum in Cameroon as the main obstacle to children's learning of mathematics.

> "... the present Cameroonian mathematics curriculum has been a significant factor in students' difficulties because it does not reflect or respond to the culture of our students. A culture-aware mathematics

> curriculum can make a significant contribution to raising levels of interest and achievement... An ethnomathematics curriculum may just be what is needed."

Another reason why he believes an ethnomathematics curriculum will be welcome is related to the fact that the current mathematics curriculum is seen to encourage discovery-learning strategies. And in a culture like that of Cameroon where children usually expect to be told what to do and where questioning an adult especially one in a position of authority like the teacher is regarded as impertinent, such a learning approach requiring questioning and being generally inquisitive is in conflict with the children's cultural background.

In terms of didactic materials, he believed that an ethnomathematics curriculum would encourage the local production of textbooks and consequently lead to a different perspective of looking at problem solving. His argument was that textbooks constitute a major barrier to cultural relevance because most of the texts are produced by foreign authors and no doubt carry foreign values. Such a situation inadvertently gives the impression to the Cameroonian child that mathematics is from and of a foreign culture. Left with this impression, children inevitably see the learning of mathematics as mainly to pass an examination. He explains:

> "Most textbooks used in the system are by foreign authors, and there is no doubt that foreign texts carry foreign values. Even texts by African writers tend to copy the European style because this has been perceived as 'correct' and 'relevant' mathematics. We now question that perception because they generally look at situations from a 'foreign angle'. ... This inevitably gives the impression that mathematics is learned to pass examinations, not because mathematics is a valued activity which Cameroonians do."

An ethnomathematics curriculum foundation would lead to a reduction in the cost of textbooks as these would now be produced locally.

6.3.5 *University Faculty*

Stakeholders' levels of interest in an ethnomathematics curriculum were often expressed in terms of what was seen as the potential benefits of implementing an ethnomathematics curriculum foundation. Benefits were often cited in terms of relevance to content, process and product such as the quality of mathematics graduates from secondary schools.

Interest related to Content

The university faculty expressed interest and the importance of looking to culture as a source for curriculum content. His motivation for pointing to culture was rooted in his views about what mathematics is and where mathematics comes from. He was quick to point to the presence of illustrations of mathematical concepts in cultural practices.

The university faculty believes that an ethnomathematics curriculum foundation would affect how students think about mathematics rather than how or what they learn. By this he is suggesting the possibility of the learner developing a better image of mathematics than the problem solving, numeracy and pen-and-paper perspectives. The following excerpts from the interview transcripts illustrate this:

> "If students know about the evolution, how these principles were created, how people thought about them, and developed them, then it could also move them to start thinking about other aspects of mathematics."

The curriculum will have benefits for student learning in terms of students being aware of mathematics as a living and growing discipline and also of the mathematics found in their own culture. Again, this view on the students developing an awareness of the presence of mathematics is supported by the university faculty's images of mathematics as he sees mathematics as neither pre-given knowledge nor *a priori* but as "human creation, developed out of practical situations."

Another possible approach as far as content is concerned could be an integration of the mathematical concepts and practices originating in the learners' culture with those of conventional, formal academic mathematics. The mathematical experiences from the learner's culture are used to understand how mathematical ideas are formulated and applied. This general mathematical knowledge is then used to introduce conventional mathematics in such a way that it is better understood, its power, beauty and utility are better appreciated, and its relationship to familiar practices and concepts made explicit. In other words, "a curriculum of this type allows learners to become aware of how people mathematize and use this awareness to learn about a more encompassing mathematics" (University faculty). It is also reasonable to "hypothesized that a curriculum of this type will motivate students to recognize mathematics as part of their everyday life, enhance students' ability to make meaningful mathematical connections and deepen their understanding of all forms of mathematics" (Adam et al., 2003, p. 332).

The level of interests expressed by the university faculty could be characterized as both actualized and situational. His level of interests can be viewed as situational in the sense that he considered the idea of an ethnomathematics curriculum foundation as very interesting although he did express concerns as to what it may entail in developing and adopting such a curriculum. His situational interest in terms of the content of mathematics were captured in the following statements:

> "[I]t is important. In fact, the historical perspective of the development of mathematics helps students realize that mathematics is not a rusty or dusty package just got from the shelves. Once you tell them how people developed mathematical ideas, students would realize that if they put up their own endeavours, they could also come out with mathematical concepts."

The above statements suggest that the university faculty is quite willing to state the importance of history in mathematics and mathematics teaching and learning so long as such utterances affect others such as secondary mathematics teachers but not him. He is clearly pointing out the interestingness of an ethnomathematics curriculum but directs the burden on the secondary school teachers.

Interest related to Process

There was also an expression of interest in the process of developing and implementing an ethnomathematics curriculum foundation. Here again, his level of interests were situational as he pointed to what secondary school teachers would need to do in their mathematics classrooms – a needed departure from the conventional ways of thinking and practice as far as mathematics is concern. He believes that a relevant cultural approach to mathematics teaching would help both students and teachers:

> "... if teachers could use group work, having students assist doing some peer teaching on certain aspects, bring aspects from their own culture into the classroom, that would even help to improve on the teacher's knowledge, and help to enlighten the usefulness of mathematics back at home... can bridge the gap between school mathematics and real life mathematics and cultural background."

The university faculty also expressed interest in the area of curriculum development as he criticized the current situation of school mathematics being made compulsory. His believes that it is not enough to simply make mathematics compulsory when students are not made to see the importance of mathematics explicitly.

> "If we want to make school mathematics compulsory, it is necessary to completely overhaul the mathematics curriculum in Cameroon so that school mathematics should tie more to real life situations and people will see the usefulness."

An important point arising from the above statements by the university faculty is whether or not school mathematics should be taught throughout the years of secondary school education and whether or not all the learners should follow the same curriculum. So requiring learners to study mathematics throughout the years from age 5 to 16 years is less easy to justify if mathematics is not as useful as is often assumed. I would argue that it is important that the changing personal preferences, career interests and vocational development plans that emerge in students during adolescence be accommodated, by a differentiated mathematics curriculum or by allowing students the opportunity to opt out altogether. If [mathematics] education is to contribute to the development of autonomous and mature citizens, able to fully participate in developing a self-reliant modern society, then it should allow elements of choice and self-determination. These are crucial issues that would need to be addressed before designing an ethnomathematics curriculum.

Interest related to Product

The university faculty also expressed interest related to what would be achieved by developing and implementing an ethnomathematics curriculum foundation. He felt that such a curriculum would provide students with the *raison d'être* of mathematics education, which to many students has been lacking. He blames this lack on the failure of teachers and the education community to make use of the abundant cultural practices such as cultural games, crafts, constructions, and the like in making the connection between school mathematics and the student's everyday cultural experiences.

6.3.6 Summary

All the teachers expressed interest in the ethnomathematics curriculum citing observed benefits such as increased student participation in classroom activities.

They see an ethnomathematics curriculum as playing the major role of demystifying mathematics, a feeling common among students especially in the lower secondary. Students are learning mathematics concepts without the uneasiness in the rigor often associated with learning pure mathematics through the traditional didactic approach. Interest was also expressed in terms of wanting to participate in the curriculum development process and not just being considered as curriculum implementers. For the students, the ethnomathematics unit gave them the opportunity to realize that mathematics is, after all, part and parcel of their everyday life, that it is a familiar, close-to-home subject, not a far-off foreign invention. The students experienced mathematical and epistemological empowerment leading to a growth in confidence, an important attitude for success in mathematics education.

An ethnomathematics curriculum would bring culture into its rightful place in mathematics education. The pedagogic adviser strongly believes that by making culture central to mathematics learning, teachers would begin to "identify concrete experiences in the students' local environment and this awareness is crucial for success in mathematics" (Pedagogic Adviser) as everyday practices. An ethnomathematics curriculum foundation would be essential for a culture like Cameroon that stresses communality, co-operation and sharing. Another important benefit of an ethnomathematics curriculum foundation would be the growth in the local production of textbooks and other teaching resources.

An ethnomathematics "curriculum of this type allows learners to become aware of how people mathematize and use this awareness to learn about a more encompassing mathematics" (University faculty) and would provide the *raison d'être* of mathematics education contrary to the perception by most students that school mathematics is mainly an education and/or career filter. If [mathematics] education is to contribute to the development of autonomous and mature citizens, able to fully participate in developing a self-reliant modern society in Cameroon, then it should allow elements of choice and self-determination.

While the main focus of this thesis has been upon assessing and understanding the stakeholders' interests and response to an ethnomathematics curriculum foundation, their expressed concerns for adopting and implementing such a curriculum are worth mentioning.

6.4 Stakeholders' Levels of Concern towards an Ethnomathematics Curriculum i.e. what changes may be needed

6.4.1 The whole group

Levels of concern were often expressed in terms of what was thought to be problematic and what was thought could easily be changed. Most of those that were thought of as problematic were either ideological – routed in the two inherited systems of education (English or French) – or practical, centering on the diversity of cultural practices and the potential financial implications.

6.4.2 Students

The only concern raised by the students centered on whether the government will be able to provide financial support for the local production of learning resources such as textbooks. This concern is very important especially considering that only an average of 60% (Tambo, 2000) of students in each classroom in Cameroon possess the prescribed texts for mathematics. One of the reasons for this textbook situation has to do with the price which most average families in Cameroon are unable to afford. The average price for the prescribed mathematics text for the junior secondary (Form 1 to 5) has been quoted at 3500 FCFA[8] (≈ 9.00 $ CDN), a price that is considered exorbitant by most average families in Cameroon. If the Cameroon

[8] In a conversation (April 10, 2003) with the pedagogic adviser and the coordinator of the Teachers Resource Centre in Bamenda, Cameroon, he laments the exorbitant prices of textbooks especially those for the national examination classes. He states that the average price for a prescribed text stands at 3500 FCFA, which is very difficult for most families in Cameroon to afford. He believes government is not doing enough to regulate textbook prices or to encourage the local production of textbooks.

government is serious about reforming the educational system, it needs to start implement all the recommendations made by the National Forum on Education of 1995 one of which focused on the cost and financing of education. In the area of teaching/learning materials, the Forum recommended the need for the "formulation of policy on the production of low-cost teaching materials and the setting up of national textbook evaluation committee" (Tambo, 2000, pp. 262-263).

6.4.3 Teachers

The teachers varied in their knowledge of, and expertise at incorporating illustrations of mathematics concepts in cultural practices and this variation was manifested in the concerns they had of an ethnomathematics curriculum foundation. Although the teachers differed in the ways they expressed their concerns about an ethnomathematics curriculum, three components were present in most descriptions. The first was about the content of ethnomathematics especially for the higher grades. The second component focused on the pedagogical processes involved in an ethno-mathematics lesson, and the third component centered on maintaining standards in mathematics education that allows for global comparison.

Concerns related to Content

> "It is good to bring in these cultural activities into the classroom. But it seems to me that this would only be good in Forms 1 and 2. Which is ok since the GCE syllabus doesn't begin until Form 3. There won't be any point using this in Form 3 and onward if they are not going to be tested in the GCE. Also, I don't know what effect this Ethnomath approach will have on the students when they move to Form 3 and switch to the usual approach. Will they find math a lot more difficult than if they had started out with the same approach right from Form 1? I don't know. You see what I mean?" (Fieldnotes with Teacher N, CCAST)

The teacher is concerned about the long-term effect on the learning of advanced mathematics if the ethnomathematics approach could not be extended to that level of mathematical sophistication. This concern is borne of the fact that the educational system is stratified and at each level, students have to write a national examination and the teacher wants to be sure that this curriculum will assess this kind of knowledge. The teacher clearly believes that the ethnomathematics unit was effective in raising the awareness of the broadness of mathematics and arousing interest in the learning of mathematics. It was certainly not my intention that all school mathematics should be taught through a cultural approach. Students who have to work with the GCE syllabus need to work with the ethnomathematics of early 20th century Britain[9] but they will approach this with an understanding that mathematics is nonetheless appropriate to their life. A continuation of this approach according to the above statements suggests that attitudes towards mathematics and the learning of mathematics would be greatly enhanced if standards were to be maintained across classrooms, grade levels and schools.

Concerns related to Process

> "Bringing in the children's day-to-day activities to explain certain concepts is good because I noticed that all the students in my class were more active than usual, even those students who are usually uninterested in mathematics. It will be good if this could work in every topic." (Fieldnotes with Teacher K, CCC)

> "But with the number of topics we have to cover in one year, it will be difficult to do this in every lesson. One of my concerns at this point (mid-way into the unit) is that, it will be good if one teacher were handling all of Form 1 or Form 2. But when you have three teachers handling one Form, it becomes very difficult to have a common exam at the end of the term which is what the HOD (head of department) wants us to do." (Fieldnotes with Teacher A, CCAST)

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[9] See page 30 for an explanation of culture as used in this study.

The teachers are making an important point here. They believe that it is very difficult, if not daunting, to measure students through a general examination which is not entirely based on what all the students have learned or experienced because each ethnomathematics lesson will depend on what each teacher determines as relevant cultural knowledge to be incorporated. This concern is also as a result of the teachers believing that, too often, students are not tested on what they have been taught but what they ought to have been taught ignoring the accommodations that teachers make due to the variation in cultural background of their students. And they argue that such an assessment does not reliably tell the teacher what help the students may need in explaining some of the content. Adopting an ethnomathematics pedagogy "will require a shift in focus away from what students cannot do" (Boaler, 2002, p. 241), to what schools can do to make the educational experience more equitable and relevant.

Concerns related to standards

> "The other day, one of my students was asking me if this was going to be in the GCE and I just told him that the GCE syllabus starts in Form 3 not Form 2. He then asked me why we were studying all this. And I told him it was to build a solid foundation so that when they get to Form 3, it will be much easier to follow the syllabus then. I mean, that's how I look at this Ethnomath approach." (Fieldnotes with Teacher B, CCC)

The above comments suggest the concern that some of the teachers, together with their students, have regarding maintaining a level of rigour while using the ethnomathematics pedagogic approach. This is an issue that has often been raised regarding ethnomathematics, but the important point to note is that an ethnomathematics approach will help the students build a solid foundation in mathematics before embarking on further studies in mathematics at the higher level. An important point also raised is the need to restructure the assessment of students in

the national examinations like the GCE and Baccalaureate so that such knowledge is recognized and accepted as legitimate mathematics.

6.4.4 Pedagogic Adviser

Although the pedagogic adviser felt strongly that an ethnomathematics curriculum foundation would be a welcome relief to Cameroon, he equally expressed concerns of what was doable and what sort of changes would need to be in place. He believes that it would be necessary first to sensitize everyone concerned with the mathematics curriculum – students, teachers, parents, curriculum planners and administrators to those aspects of the curriculum which are culturally irrelevant. He is however concerned that with over 200 subcultures in Cameroon this may prove very difficult but doable if the major cultures were to be considered. This could be done through workshops and seminars where certain common cultural practices are identified and could serve as teaching/learning aids for mathematics in the beginning and then more elaborate inclusions with time. Below, the pedagogic adviser lists what may need to change or be put in place before such a curriculum becomes a reality:

(i) Need to decentralize the structural set up of the educational system giving more power to the provinces.

(ii) The government would need to invest in the preservice and inservice teacher training.

(iii) Workshops and seminars on documenting some of the cultural processes would need to be sponsored by the government.

(iv) Findings of the various workshops and seminars would be examined by provincial commissions and then by an inter-provincial commission, to determine those aspects that are most representative of Cameroonian culture.

(v) Government would need to invest in textbook production locally or encourage this through grants and incentives.

(vi) The government would need to provide additional funding to teacher resource centres.

(vii) The already acute shortage of mathematics teachers may threaten the whole educational system.

(viii) Teachers already are overloaded and may feel that the new curriculum would be too tasking in terms of what they would need to know and be able to do in the classroom.

(ix) The national examinations like the GCE and the Baccalaureate would need to be reorganized to assess mastery of these cultural practices. It is likely that this reorganization may entail additional financial burden in the production of examination materials for the national examinations like the GCE and the Baccalaureate.

(x) Government policy with regards to the recommendations of textbooks would need to change by providing provinces with some leverage in deciding on textbooks for its province.

6.4.5 University Faculty

Levels of concern by the university faculty were often expressed in terms of what was thought could be problematic and what was thought could easily be changed or required to change. Most of what was thought of as problematic was either ideological – rooted in the two inherited systems of education (English or French) – or practical, centering on the diversity of cultural practices and the potential financial implications.

Mathematics education is not only about learning some mathematics concepts and processes but also about how to assess how successful this acquisition of skills and concepts is occurring. Because the educational systems are highly examination oriented, the university faculty felt that changes would need to be made such as assessing this kind of knowledge before students and teacher would realize its importance.

"The big, big problem we have in Cameroon with this attitude is the structure of the system... our educational system is highly examination oriented. Until such a time that the examination systems would try to assess this type of knowledge, would it then make teachers realize just how necessary it is to bring it into their classrooms. The syllabuses are already so compact that it is difficult for teachers to deviate. And even any deviation you would find students saying 'But would this come in the exams?' They (students) like to see ideas that are reflected on examination questions... So this is the problem. But it would be a good idea."

The university faculty, while expressing interest in an ethnomathematics curriculum foundation, believed that for such a curriculum to be successfully implemented, the following changes will need to occur:

(i) The teacher will need to be knowledgeable about other aspects and uses of mathematics.

(ii) Examinations will need to assess this kind of mathematics knowledge related to real life.

(iii) The government will need to invest in the production of resource materials.

(iv) A national education forum would need to be organized comprising teachers, university personnel, pedagogic personnel, parents, specialists in cultural studies, and curriculum specialists.

(v) The government would need to set out the aims and goals of (math) education.

The university faculty also expressed some concerns regarding the development of such a curriculum. These were:

(i) A cultural approach may provide the impetus to harmonize the two inherited systems of education that clearly has never been achieved. This could be a potential source of dissonance as experienced two decades ago when the then minister of education attempted to harmonize the two systems by marginalizing one of them.

(ii) Teachers may feel they need to develop expertise in an extensive amount of cultural activities.

(iii) Choice of which cultural knowledge to include given the numerous cultural practices may lead to one inherited culture (most possibly English) becoming even more marginalized.

(iv) There could be competition among cultures for representation.

Need for In-service Teacher Education

The university faculty echoed the same point made by the teachers and pedagogic adviser regarding teacher education. He believes that the government needs to invest in teacher education by setting up workshops and seminars for inservice teachers, and by reforming the teacher education program at the various teacher-training institutions. This is a point which has been highlighted by many a mathematics educator who cite the lack of continuous teacher re-education as contributing to the failures in mathematics education reform. Burton (2003), for example, maintains that if we are really serious about creating "a mathematically aware and competent citizenry able to appreciate the joys of mathematics, as well as its usefulness," (p. 171) then we must be willing to "re-educate those outside the classroom as to why a transmissive approach to a school syllabus simply does not and cannot work." Burton believes that reconciling the differences between school mathematics, mathematics in the world and academic mathematics is what is needed. He declares that it is our duty to persuade those in policy and decision making positions that teachers need a long, sustained programme of in-service education that allows them to learn the why and work at the how.

6.4.6 Summary

In this section, I have endeavoured to highlight and illuminate the various areas of concern expressed by the stakeholders towards the possibility of adopting and implementing an ethnomathematics curriculum for secondary schools in Cameroon. Most of the concerns were logistical punctuated with a political tone. Because the country is bicultural (French and English) with the Francophones in the

majority, almost every concern echoed by the stakeholders had a political tone to it. It is therefore safe to say that the challenges in adopting an ethnomathematics curriculum foundation as identified above are subsumed under the political dynamics of the state. Hence a change in the political structure may facilitate the adoption of such a curriculum.

Because this project was premised on the assumption that stakeholders' views and images of mathematics would influence their response to an ethno-mathematics curriculum, the stakeholders' images and views of mathematics were accessed using both semi-structured interviews and a questionnaire containing open-ended and direct questions. This data has provided a glimpse of some of the images held by the stakeholders. Moreover, consistency between questionnaire and interview data suggests that these images were not arbitrary. Although this confirmation is only available for data obtained from the stakeholders that both completed a questionnaire and were interviewed (teachers, pedagogic adviser, and university faculty), it does provide some basis for confidence on the stability of the responses. In addition, their links to the stakeholders' teaching philosophies suggest deep-seated origins. In this chapter I have pointed out that while there are levels of interest in an ethnomathematics curriculum foundation, there are equally challenges or concerns that will need to be addressed for a successful implementation.

6.5 Conclusion

An ethnomathematics curriculum presents new challenges for teachers and teacher educators. Building on children's informal mathematics knowledge will require going beyond a view of mathematics as a decontextualized and sequenced set of skills that students need to memorize, and toward asking questions about and valuing how children use mathematics in their everyday lives (Nunes & Bryant, 1996; Sleeter, 1997). It will necessitate, as Ladson-Billings (1997) suggests, that

teachers study their students and their backgrounds, becoming students of their students.

The students' interests in the ethnomathematics unit tended to be more situational as the students seemed to focus more on the interestingness of the mathematics lesson activities, activities which they were familiar with. If students had any concerns regarding the ethnomathematics unit, it was expressed in terms of the demands the lessons had. For example, students found it difficult to investigate some identified cultural activities and explain the mathematics present in them. But when students were able to locate the mathematics knowledge embedded in the cultural activity, they were eager to share with the rest of the group. Some students were even able to develop a form of algorithm for arriving at a predetermine outcome in a particular mathematics game. The study also noted that as students became more active in class, their concerns about not doing well in mathematics diminished and they didn't care much if mathematics remained a compulsory subject or not. Students who had always experienced success in mathematics sometimes wondered if they were really studying mathematics and if that knowledge was going to be tested in the end of year or end of program exam. In fact, all the stakeholders believed that it was important that students be recognized and tested on this mathematics knowledge in the GCE examination to signal its importance and usefulness.

The teachers in this study showed interests in an ethnomathematics curriculum but were equally concerned about the demands such a curriculum would place on the student's and teacher's cultural background knowledge. The teachers demonstrated both situational and actualized forms of interest that were complex and varied. When a particular cultural activity facilitated mathematics teaching and learning, the stakeholders exhibited actualized interest to an ethnomathematics curriculum. In this instant, teachers were totally convinced of the benefits of an ethnomathematics curriculum and felt they were well equipped to

adopt and implement this curriculum foundation. When the lesson activities demanded much from the teachers in terms of cultural background knowledge and the teaching and learning implements, the teachers showed situational interest. That is, they remain interested in an ethnomathematics curriculum with the hope that this new curriculum vision may eventually become interesting. What also emerged from the analysis of the teachers' response to the ethnomathematics curriculum foundation is that teachers' interests are more complex and interrelated and is influenced more by external factors than by a given phenomenon.

Another point that emerged was that teachers' concerns were sometimes derived out of their awareness of their effectiveness in implementing curriculum, which for the past half century has been dictated by the government in a top-down approach to curriculum development. One can easily understand this point regarding teacher effectiveness based on the concept of self-efficacy. *Self-efficacy* is the belief that one is capable of exercising personal control over one's behaviour, thinking and emotions. Effective teachers believe that they can make a difference in children's lives, and they teach in ways that demonstrate this belief. What teachers believe about their capability is a strong predictor of teacher effectiveness. For a cultural approach to mathematics teaching to be successful, teachers need to have a sense of *cultural self-efficacy* i.e. a belief in their capability as teachers to perform specific actions in culturally appropriate ways in specific teaching situations.

The aims of the curriculum reform would be to make mathematics instruction at the secondary school level culturally relevant in the Cameroonian context, while maintaining the internal consistency of the discipline and allowing the teachers to be effective or experience a sense of efficacy. In this way, we can ensure that even if the mathematical content for secondary schools remains little changed, children will have the opportunities for learning that content from starting points based in their own culture and with reasoning which reflects the argumentation and values of their own culture.

It may be true that when looking for jobs, students will be required to know traditional school mathematics. But there is much more in educational goals than merely to provide utilitarian instruments. Education must enhance cultural dignity. To enhance cultural dignity and to be prepared for full participation in society requires more than what is offered in the traditional curricula which in most developing countries remains inappropriate and lacking in mathematical, social and epistemological empowerment. As D'Ambrosio (2002) aptly states:

> "Particularly serious is the situation of mathematics, which is largely obsolete as present in the classrooms. Classroom mathematics has nothing to do with the world the children are experiencing. [...] We need more and better mathematical contents [that generates interest], which cannot be interpreted as conceptual errors or a relaxation of the importance of serious mathematical contents of a modern nature." (D'Ambrosio, 2002, pp. 3-5)

The university faculty expressed interest in the ethnomathematics curriculum foundation and felt that the richness of the Cameroonian culture was a fertile ground for a relevant cultural approach to mathematics education. He asserted that such a curriculum would require a complete change in thinking and a re-examination of the educational system. He also cited the need for changes in teacher education, especially mathematics teacher education, by highlighting the need for courses in the history of mathematics, cultural studies, and philosophy of mathematics and mathematics education. Some potential areas of difficulty such as the costs in the development and implementation of such a curriculum given the present economic situation of the country were also highlighted as well as views related to conceptions of knowledge and the role of the teacher in knowledge construction.

The pedagogic adviser was very enthusiastic about an ethnomathematics curriculum foundation and felt that the very idea of a cultural approach to the secondary school mathematics curriculum was long overdue. His suggestion was

that an ethnomathematics curriculum conception need not be restricted to the secondary mathematics curriculum but should be extended to the elementary level where the initial stones of formal mathematics learning are laid. In this connection, he suggested that for teachers to teach mathematics effectively, they not only will need to possess an in-depth understanding of the content in the culture but also must share culturally compatible communication styles and variables. In summary, he is suggesting that for mathematics instructions to be culturally sensitive, content and pedagogy must be culturally congruent.

To summarize, the potential areas of consternation to a successful development and implementation of an ethnomathematics curriculum foundation in Cameroon as identified by the stakeholders included:

1. Logistical difficulties involved in structuring a system involving all the stakeholders.

2. Political difficulties of convincing those who wield power under the current system to share power in a new system (at levels ranging from classrooms to the ministry of education).

3. Challenge of sustaining ongoing interest, commitment, and involvement of all the stakeholders especially in developing curriculum materials and evaluating the success of the curriculum.

4. Challenge of sustaining administrative leadership, commitment, and continuity in supporting the system (i.e. allocating resources).

5. Lack of resources to pay for in-service teacher education.

6. Requirement in additional time and interest on the part of teachers in broadening their knowledge of cultural practices relevant to every topic to be taught.

7. The question of which cultural practices will be selected and what values and purposes will underpin that selection and the way they are structured must materially determine the nature of school mathematics.

Chapter 7

CONCLUSION, IMPLICATIONS, AND RECOMMENDATIONS

7.1 Conclusion

In the preceding chapters, I have attempted to make the case for the need to reform the secondary mathematics curriculum for schools in Cameroon. In Chapter 1, I laid out the current situation with mathematics education arguing that the poor performance of students in mathematics and the steady decline in enrolment is attributable to the alien nature of the school mathematics curriculum. I have pointed to the inappropriateness of the curriculum in content, context and process and suggested that relevant mathematics education will have to start with a clear educational policy and government investment in the local development of teaching/learning resources.

My review and analysis of the evolution of the school curriculum have shown that the fact that Cameroon, as a formerly colonised region of the world is still grappling with two inherited educational systems (British and French) since independence, more than forty years ago indicates a dire need for major educational reforms. I have argued that if Cameroon is really serious about educating its citizens, about providing an education for self-reliant development, then it needs to create an educational system that is Cameroonian in nature, and that takes into consideration the present realities in the country. I have also suggested that creating an educational system that can produce the kind of individuals, i.e. useful citizens that Cameroon needs in the 21st century will require harmonizing the two systems of education so that students with an English cultural background have the same opportunities as those with the French background.

I have endeavoured in Chapters 5 and 6 to show the various levels of interest in an ethnomathematics curriculum by analyzing statements made by the stakeholders in response to possibilities of an ethnomathematics curriculum for Cameroon. The analysis reveals that the stakeholders' receptiveness to an ethnomathematics curriculum is complex and varied and not dependent on a particular phenomenon.

Despite my attempts, however, to show, through analyses of stakeholders' responses to interview and questionnaire questions that there is a high level of interest and a positive response to an ethnomathematics curriculum foundation, critics of an ethnomathematics curriculum might still justifiably wonder whether or not the development and adoption of an ethnomathematics curriculum is possible in Cameroon if it requires that certain cultural practices be considered for their mathematics content and that teachers become knowledgeable and competent in incorporating these cultural practices into their mathematics lessons. What this study has revealed as common among the stakeholders is their recognition of the importance of a relevant mathematics curriculum.

What remains to be elaborated, however, is the nature of the challenges of adopting an ethnomathematics curriculum in a country rich in culture like Cameroon. I therefore devote the last part of this chapter to outlining the things that Cameroon would need to do or pay attention to in order to successfully develop and adopt an ethnomathematics curriculum for its secondary schools.

7.2 Implications

7.2.1 Implications for Teacher Education

These findings have relevance for in-service teacher education. The failure of many in-service teacher courses to transfer learning back to the classroom is commonly reported. It is not simply that there has been a failure in generalizing the

learning experiences to new situations. Rather, for change to endure, teachers need to transform their excitement about good or new ideas into change in self-belief. As teachers' self-efficacy is enhanced, so too is their persistence, resilience and willingness to engage in innovative practices. This is because experience of competence and personal control, the feeling of autonomy and self-determination, and a positive emotional state characterize interest-driven actions.

Because most teachers do not have enough historical expertise, and do not have access to the right materials to make a historical approach in their lessons possible, an in-service training will be necessary for all teachers already in the field to help improve their knowledge and assist them in developing teaching materials.

Implementing a genuine ethnomathematics curriculum foundation will require that the entire mathematics curriculum be structured so that mathematical concepts and ethnomathematical aspects are synthesized with texts and other materials reflecting these perspectives. Other methods of curriculum assessment e.g. projects, portfolios, etc. will be required.

Ethnomathematics pedagogy will need to be embedded within the teacher education curriculum and not taught as a separate strand.

7.2.2 Implication for mathematics education

An ethnomathematical curriculum foundation will provide a realistic mathematics education that is much needed in a country like Cameroon. Such an education will aim at the construction by children of their own mathematical knowledge by giving meaning to problems from the children's real world context. In such a curriculum, children will be challenged to develop their own [informal] strategies for solving such problems, and discussing their [solution] approaches with other children. However, finding solutions to real-world problems should not be the end of mathematics lessons within an ethnomathematics curriculum foundation. Teachers will need to extend this learning by helping the children develop their in-

formal strategies into more formal approaches which they can then use in other situations.

Benefits of using a Historical Approach

According to Schubring (1988) there is a connection between students' mistakes, cognitive obstacles, and problems in the historical development of mathematics. Knowledge of the important moments of history can thus provide teachers with a tool for anticipating epistemological obstacles in the learning of mathematics. A historical problem offers students a good opportunity to get the experience of changing their perspective in solving problems, because of the variety of methods from various periods that have been applied to solve them. Showing students the dynamics of the mathematical development helps them to reconsider their belief of a static mathematical branch and will get students to appreciate the fact that mathematics is a product of the human mind. But the analysis of historical texts and making the texts accessible to students is not an easy task. The crucial steps of the historical documents have to be identified and reconstructed so that they become appropriate for classroom use. An important aspect is to find suitable questions so that students become deeply involved in the historical context under study.

Several researchers and educators promote the need for teaching the history of mathematics at teacher training courses so as to enrich the didactical repertoire of the teacher. van Maanen (1997) argues that "a look at 'old methods' can help teacher and students to evaluate their standards, to step away for a while from 'just doing mathematics' to thinking and speaking about what they are doing, and then to step back to doing, but now doing it more deliberately".

Barbin (1996) argues that history of mathematics changes the epistemological concepts of mathematics by emphasizing the construction of knowledge out of the activity of problem solving. Reading old sources gives a better insight in the essence of what mathematics is and improves one's didactic skills as a teacher.

Showing that mathematics is something which has been invented by people at particular stages in history, not something which has always been there makes mathematics more concrete and gives students more insight. Through re-examining the development of known and taken-for-granted mathematical concepts, methods or proofs, students can see that in former days mathematicians now considered as being outstanding also had their doubts and made mistakes (Arcavi, 1991; Ofir, 1991). Students derive comfort from realizing that they are not the only ones with problems so that they get less discouraged by misunderstandings and mistakes.

History of mathematics can help to develop a cultural approach in the classroom. Mathematics in its modern form is mostly viewed as a product of western culture. Through the study of history less known approaches to mathematics, ethnomathematics, which appeared in other cultures, can be considered (Barta, 1995). Students will be encouraged to discuss mathematical ideas, apply mathematics to solve everyday problems, formulate mathematics problems from everyday situations, and to investigate the history of mathematics in Cameroon.

History can help explain the role of mathematics in society. Mathematics is a dynamic activity influenced by social and cultural factors. Knowledge of the sources of mathematics is therefore an integral part of the knowledge of mathematics (Ofir, 1991). It is our solemn responsibility to give students the opportunity to see that mathematics is driven not only by utilitarian reasons, but also developed for its own sake, motivated by intellectual curiosity, recreational purposes and aesthetics criteria. Exploring history of mathematics helps to increase students' interest for learning. They may make mathematics lessons less frightening, more enjoyable and exciting. It also enables brighter learners to look further.

7.3 Recommendations

1. One of the most fertile areas of controversy in curriculum theory is the concept of curriculum. In Cameroon, curriculum authorities have ascribed to a definition that limits curriculum development to the writing of syllabuses in the traditional school subjects and to the requirements of examination systems such as the General Certificate of Education or the Baccalaureate. Such a practice appears to contradict the view of the informed public that continues to emphasize the need for schools to be directly involved in community improvement by extending their activities well beyond the school building. The Cameroon school may not be able to pursue this goal effectively if curriculum development continues to be limited to syllabus writing in the traditional school subjects; subjects whose contents are determined for the most part by textbook authors and publishers. In this connection, Cameroon will need to adopt a broader view of school curriculum and basing curriculum development activities on real student and societal needs. When developing curriculum materials for mathematics instruction, Shirley's (1995) broader classification[10] of mathematics would be used to ensure that the narrow academic orientation given to mathematics in formal school curricula – a situation that, in itself, has driven many students away from mathematics – is broadened, so that students would appreciate mathematics in its entirety.
2. To encourage the proliferation of curriculum development products it would be necessary that authority be devolved on provincial and divisional educational authorities and adequate guidance, support and supervision provided from the Central Office at the ministry of education so that different kinds of materials can be produced at different levels of the school system. This is

[10] Shirley (1995) classifies mathematics broadly into pure (academic, recreational) and applied (occupational, everyday), with academic and occupational seen as formal mathematics while recreational and everyday as informal mathematics.

important, considering that one practical way to improve curriculum practice in a school system is by introducing a variety of curriculum products that are valued by teachers, pupils and parents.

3. Teacher shortage is a major problem at all levels of the Cameroon school system. To combat this shortage, Cameroon has focused its energies on preservice teacher education to the extent that the educational needs of teachers in-service have not received adequate attention. However, Cameroon's educational authorities do recognize the importance of in-service teacher education in the curriculum improvement process by sponsoring conferences, workshops and seminars involving in-service teachers. But what Cameroon would need to do is design and implement a more comprehensive in-service teacher education programme in terms of specific curriculum development needs for Cameroon schools.
4. The improvement of the quality of education in a school system requires the development of adequate strategies and sustained action in key domains of the schooling process. One of these is the curriculum, sometimes described as the heart of the schooling process. To ensure that the curriculum remains responsive to the needs of the Cameroonian students and society, curriculum improvement will need to be a continuous process requiring frequent evaluation and analysis of strategy and issues related to that process.
5. Teachers will need to be encouraged to take advantage of the many cultural games children play everyday, to teach some mathematics concepts. Games are only one of the cultural activities that can be integrated into the curriculum. In fact, Bishop's (1988) six fundamental activities (counting, locating, measuring, designing, playing and explaining) identified as necessary and sufficient for the development of mathematical knowledge and carried out by every culture can be used by the teacher to identify curricular resources.

Recommendations for Future Research

Although this study has illuminated some interesting findings with regard to stakeholders' level of interests to an ethnomathematics curriculum foundation, it does not measure the degree to which such interests are held and expressed. Therefore, I recommend that future research be conducted to examine the degree of these interests.

The study was framed as a case study focusing on just two schools in Cameroon. These schools were selected because of their interestingness and not because they were necessarily representative of secondary schools in Cameroon. As a result, the findings in this study are very limited in their generalizability and representativeness. I therefore suggest that future research include a larger and more fully representative case by including mission secondary schools and koranic schools.

The study was conducted with students, teachers, pedagogic personnel and university faculty as major curriculum stakeholders. The results of this research can thus not be considered as representing all the curriculum stakeholders in Cameroon. Future research needs to be conducted to include other stakeholders such as the parents, entrepreneurs, and religious leaders in order to get a complete picture of the level of interests of all those who in one way or the other have a stake in the kind of education that would help Cameroon become self reliant and self sustaining.

The research was conducted only over a one-term (semester) period lasting four months, the nature of the interests expressed by the stakeholders towards a proposed ethnomathematics curriculum foundation was limited in terms of how long lasting the enthusiasm towards the curriculum would be. It would be interesting to find out how the level of interests if affected by carrying out a longitudinal study for a longer period of time.

The findings in this study are based on data collected in only one of the two colonially-inherited systems of education currently in Cameroon i.e. the English. The

results therefore do not represent the responses from the stakeholders regarding the two systems of education. If the curriculum recommendations of this study are to be considered, it would necessary to carry out extensive studies in both systems of education especially as both systems differ considerably in terms of their philosophy of mathematics education.

Furthermore, results of this study suggest that there are striking similarities and differences in the nature of concerns among the stakeholders as to the changes that would need to occur within the educational system before an ethnomathematics curriculum could be developed and implemented. Most of the concerns of the stakeholders centered around government's reluctance towards genuine curriculum reform that will lead to decentralization of powers by giving the provincial educational authorities more powers in the area of curriculum change. Further research could be conducted to include personnel from the ministry of education in order to shed some light on this.

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APPENDICES

Introduction

Appendix A contains the sample Letters of Information and Request for Consent as were used to obtain permission and secure consent. These letters are followed by the questionnaires and the Interview Protocol.

Appendix B contains sample lesson activities of the ethnomathematics unit that was taught to Form 2 students in the two secondary schools involved in the study.

Appendix A

THE UNIVERSITY OF BRITISH COLUMBIA

Centre for the Study of
Curriculum and Instruction
Faculty of Education
2125 Main Mall
Vancouver, BC, Canada V6T 1Z4
Tel: (604) 822-5602
Fax: (604) 822-8234
Web: www.csci.educ.ubc.ca

Date: _____

The Provincial Delegate of Education,
North West Provincial Delegation of Education,
Bamenda, North West Province,
Cameroon

Dear Sir,

Re: Application for Permission to Conduct Research in _____

I, Henry Kang, a doctoral student at the University of British Columbia, Canada have the honour most respectfully to inform you of a research project to take place at _____ and to seek your permission to conduct the research in the school.

The purpose of the project is to examine the stakeholders' (pedagogic inspector/adviser, university faculty, teachers, and students) interest and response towards a proposed alternative foundation to the secondary school mathematics curriculum in Cameroon. Please find attached a detailed description of the research study.

I hope you will consider giving your permission to conduct this study at _____, as I believe that it will be interesting and beneficial to all who take part and also help the researcher in providing valuable foundational guidelines for future systemic reforms in the school curriculum in Cameroon and other postcolonial nations. If you have any questions or concerns, please do not hesitate to contact me at the address/phone number below or contact the Director of the UBC Office of Research Services and Administration, at 001-604-822-8598.

This project has the approval of the University of British Columbia, Canada.

Yours faithfully,

Letter of Permission to Conduct a Research Project in _____

Responsive Mathematics Education: An Ethnomathematical Foundation

Name of Provincial Delegate of Education: _____

Address: _____

_____

I, _____,
have received a letter of information explaining the nature of a mathematics research project to be conducted at _____ by Mr. Henry Kang during January to April 2003. I am satisfied with this explanation and the requirements of this school's voluntary participation. I understand that the data which he will collect will be used anonymously in written descriptions of the study in his doctoral dissertation, and that the data will be archived using code numbers with all identifying information removed, for a period of at least five years in a locked filing cabinet.

I grant / I do not grant Henry Kang permission to contact the above school to organize his research project. I understand that I am free to revoke this permission at any time and that the school is also free to withdraw from the project at any time. I also understand that if for any reason this permission is withdrawn, that the school retains the right to all the data collected from its participation in the study up to that point.

I have received a copy of the letter of information and consent form for my records.

Signature of Provincial Delegate of Education: _____

Date: _____

CF version: August 27, 2002

Letter of Permission to Conduct a Research Project in _____

Responsive Mathematics Education: An Ethnomathematical Foundation

Principal's Name: _____

Address: _____

_____

I, _____, consent / do not consent to allow Henry Kang to conduct research in mathematics at _____ during January to April 2003. I grant him permission to contact teachers in this school to seek their voluntary participation in his research project. I understand that the data which he will be collecting will be used anonymously in written descriptions of the study in his doctoral dissertation, and that the data will be archived using code numbers with all identifying information removed, for a period of at least five years in a locked filing cabinet.

The nature of the project has been explained to me and I am satisfied with this explanation and the requirements of this school's voluntary participation.

I understand that I am free to revoke this permission at any time without jeopardy to my employment, and that should this be the case, that this school retains the right to all the data collected from its participation in the study up to that point.

I have received a copy of the letter of information and consent form for my records.

Principal's Signature: _____

Date: _____

CF version: August 27, 2002

Letter of Consent to Participate in a Research Project
Responsive Mathematics Education: An Ethnomathematical Foundation

University Faculty's Name: _____

Address: _____

_____

I, _____, consent / do not consent to participate in the research project in mathematics conducted by Henry Kang from January to April 2003. I give him permission to use the data collected from my recorded sessions with him and any other data collected during the study. I understand that the data will be used anonymously in written descriptions of the study, and that the data with all identifying information removed, will be archived using code numbers for a period of at least five years in a locked filing cabinet.

The nature of the project has been explained to me and I am satisfied with this explanation and the requirements of my voluntary participation.

I also understand that I am free to withdraw from the project at any time without jeopardy to my employment, and that should this be the case, that I retain the right to all the data collected from my participation up to that point.

I have received a copy of the letter of information and consent form for my records.

University Faculty's Signature: _____

Date: _____

CF version: August 27, 2002

topic in Form 2 mathematics and I may occasionally lead the teaching of a particular concept. The teachers will complete a questionnaire (30 minutes long) and will also be interviewed prior to developing the mathematical topic and also after teaching the mathematical topic. Each interview session with the teacher will last approximately one hour long. All the information from the questionnaire and interview sessions will help the researcher develop a better understanding of the teachers' interest and response to an alternative foundation of the school mathematics curriculum.

All students participating in the study will receive instructions for the same mathematical topic. One stream of Form 2 (the experimental group) will be taught the co-developed mathematical topic while the other stream (the control group) will follow the regular mathematical topic developed by the teacher alone. At no time will a student who needs help be deprived of that help for the sake of the research. All participation in this study is strictly voluntary. Any participant can withdraw from the study at any time. Withdrawal from the study simply means that any data collected on that student will be destroyed and no further data collected. It does not mean that the student will not be taught mathematics. The teaching/learning of mathematics will continue, with all students in the Form 2 class participating.

Some classroom sessions will be audiotaped. Students will be encouraged to reflect on their learning of mathematics and discuss their thinking and problem solving processes with each other, myself, and with the teacher. In addition to clarify thought processes for the researcher, the reflective process should prove valuable to each student and to the classroom teacher. Through this reflection, each student will benefit as a participant in the project.

In addition to daily taped sessions which focus only on the teacher and consenting students, all students in both groups will complete a questionnaire at the start and end of the mathematical topic but only data from all those who consented will be analyzed. The information gathered from the questionnaire will provide a deeper understanding of student's attitudes and feelings towards school mathematics. The information may also help in designing a more responsive mathematics curriculum for Cameroonian secondary schools.

All data collected in the school will be available only to the individual participant who provided it, the researcher, and the researcher's supervisory committee. At the end of the study a summary of the data collected will be available for review by the pedagogic inspector/adviser and the teacher. All data will be used anonymously in written descriptions in the dissertation. All data will be archived for a period of at least five years.

I hope you will consider giving your permission to conduct this study at _____, as I believe that it will be interesting and beneficial to all who take part and also help the researcher in providing valuable foundational guidelines for future systemic reforms in the school curriculum in Cameroon and other postcolonial nations. If you have any questions or concerns about your rights to participate in this study, please do not hesitate to contact me at the address/phone number below or contact the Director of the UBC Office of Research Services and Administration, at 001-604-822-8598.

This project has the approval of the University of British Columbia, Canada.

Letter of Permission/Consent to Participate in a Research Project
Responsive Mathematics Education: An Ethnomathematical Foundation

Provincial Pedagogic Inspector's Name: _____

Address: _____

_____

I, _____, have received a letter of information explaining the nature of a mathematics research project to be conducted at C.C.A.S.T. Bambili by Mr. Henry Kang during January to April 2003. I understand that the data which he will collect from the above school and also from my recorded sessions with him will be used anonymously in written descriptions of the study in his doctoral dissertation, and that the data will be archived using code numbers with all identifying information removed, for a period of at least five years in a locked filing cabinet. I am satisfied with this explanation and the requirements of the school's and my voluntary participation.

I grant / I do not grant him permission to contact the above school to organize his research project. I understand that I am free to revoke this permission at any time and that the school is also free to withdraw from the project at any time. I also understand that if for any reason this permission is withdrawn, that the school retains the right to all the data collected from its participation in the study up to that point.

I consent / I do not consent to participate in the research project. I understand that I am free to withdraw from the project at any time without jeopardy to my employment, and that should this be the case, that I retain the right to all the data collected from my voluntary participation up to that point.

I have received a copy of the letter of information and consent form for my records.

Provincial Pedagogic Inspector's Signature: _____

Date: _____

CF version: August 27, 2002

All students participating in the study will receive instructions for the same mathematics topic. One stream of Form 2 (the experimental group) will be taught the co-developed lessons while the other stream (the control group) will follow the regular lessons developed by the teacher alone. At no time will a student who needs help be deprived of that help for the sake of the research. All participation in this study is strictly voluntary. Any participant can withdraw from the study at any time. Withdrawal from the study simply means that any data collected on that student will be destroyed and no further data collected. It does not mean that the student will not be taught mathematics. The teaching/learning of mathematics will continue, with all students in the Form 2 class participating.

Some classroom sessions will be audiotaped. Students will be encouraged to reflect on their learning of mathematics and discuss their thinking and problem solving processes with each other, myself, and with the teacher. In addition to clarify thought processes for the researcher, the reflective process should prove valuable to each student and to the classroom teacher. Through this reflection, each student will benefit as a participant in the project.

In addition to daily taped sessions, all students in both groups will complete a questionnaire at the start and end of the mathematics topic. The questionnaire will take no more than 30 minutes. The information gathered from the questionnaire will provide a deeper understanding of student's attitudes and feelings towards school mathematics. The information may also help in designing a more responsive mathematics curriculum for Cameroonian secondary schools.

There is no obligation to have your students' work or your work become data for my study. If you should choose not to allow any of the students' responses and written work to become data for my study, I want to assure you that this will not affect the students' involvement, your involvement, or my involvement in the daily teaching and learning of a culturally rich mathematics unit.

I hope you will consider giving your consent to participate in this study, as I believe that it will be interesting and beneficial to all who take part and also help the researcher in providing valuable foundational guidelines for future systemic reforms in the school curriculum in Cameroon and other postcolonial nations. If you have any questions or concerns about your rights to participate in this study, please do not hesitate to contact me at the address/phone number below or contact the Director of the UBC Office of Research Services and Administration, at 001-604-822-8598. If you do give your consent and later would like to withdraw, you have every right to do so. Likewise, I also have the right to withdraw from any participation I have in the study.

This project has the approval of the Provincial Delegation of National Education, the Principal of your school and the University of British Columbia, Canada.

Would you please confirm your agreement regarding your willingness to participate by completing the attached form.

Yours faithfully,

Letter of Consent to Participate in a Research Project

Responsive Mathematics Education: An Ethnomathematical Foundation

Teacher's Name: _____

Address: _____

_____

I, _____, consent / do not consent to participate in the research project in mathematics conducted by Henry Kang at _____ during January to April 2003. I give him permission to use portions of the children's work, data from my recorded sessions with him and any other data collected during the study. I understand that the data will be used anonymously in written descriptions of the study in his dissertation, and that the data will be archived using code numbers for a period of at least five years in a locked filing cabinet.

The nature of the project has been explained to me and I am satisfied with this explanation and the requirements of the participants.

I also understand that I am free to withdraw from the project at any time without jeopardy to my employment. This withdrawal will not mean denial of the experience in infusing culturally relevant knowledge into the mathematics curriculum. Also, should I decide to withdraw, that I retain the right to all data collected from my recorded sessions with him.

I have received a copy of the letter of information and consent form for my records.

Teacher's Signature: _____

Date: _____

CF version: August 27, 2002

THE UNIVERSITY OF BRITISH COLUMBIA

Centre for the Study of Curriculum and Instruction
Faculty of Education
2125 Main Mall
Vancouver, BC, Canada V6T 1Z4
Tel: (604) 822-5602
Fax: (604) 822-8234
Web: www.csci.educ.ubc.ca

Date: _____

Interview Protocol

(Faculty/Provincial Pedagogic Inspector/Teacher)

The interviews will be semi-structured using questions of the form given below. Throughout the course of the interviews, I will raise questions that will reveal the informants' interests in reform and curriculum change. I will rely on a discovery-oriented, inductive approach to interviewing by allowing interviewees to discuss issues off the list of questions that they feel is fundamental to successful curriculum change. The concepts I will try to elicit are: nature of mathematics, uses of mathematics, mathematics and culture, curriculum development, mathematics teaching and learning, and education in Cameroon.

1. I want to ask you some questions about the ***nature of mathematics***.
   - How has mathematics developed over the years from time immemorial?
   - Do you consider doing the history of mathematics as doing mathematics?
   - Are there other forms of mathematizing?
   - How relevant are students' everyday experiences in your planning of mathematics instructions?
   - Do teachers expect students to know mathematics which they were not explicitly taught?
   - What can be done to make mathematics more 'natural' to students?
   - How would you respond to a student who says that 'getting the correct answer to a mathematics problem is more important than investigating the problem in a mathematical manner'?

   Finally, where is mathematics?

2. I want to ask you some questions about the ***uses of mathematics***.
   - Why do you teach mathematics in schools or how would you respond to a student's question: "Why are we learning this mathematics topic?"?
   - What role does mathematics education play in the educational development of Cameroon?

- What role does mathematics education play in achieving the goals of educating Cameroonians in the 21st Century?
- Should mathematics remain a compulsory subject at the secondary school?
- Considering Cameroon's bicultural colonial heritage, what kind of national curriculum in mathematics should be developed that caters to the needs of both systems of education?

3. I would like you to talk to me about the connection between ***mathematics and culture.***
   - Is mathematics a culturally neutral discipline or should we even be talking about culture in mathematics?
   - Is mathematics a value free discipline or should we even be talking about values in mathematics?
   - There are some who would argue that mathematics is a *culture-free* discipline i.e. the propositions of mathematics are absolute and transcends questions of culture since 2 + 2 = 4. How would you respond to such an argument?

4. I would like to ask you some questions about the ***curriculum reform*** process in school mathematics.
   - Who are those you think are involved in the curriculum development and implementation process taking the case of school mathematics?
   - If you were to be charged with the responsibility of designing the mathematics curriculum for secondary schools in Cameroon, what are some of those things you would consider or pay attention to?
   - As a continuation of the previous question, what are some of the things you would like to see taken out of the curriculum?
   - Who are those you think are involved in selecting official mathematics texts to use in secondary schools in Cameroon?

5. Let's talk about the present ***mathematics curriculum*** in used in Cameroonian secondary schools.
   - What purpose was the present mathematics curriculum designed to serve? To what extent has this purpose been served?
   - What flaws in the curriculum itself could have undermined its effectiveness? How could these flaws be eliminated and/or remedied?
   - How can new variables be accommodated for ultimate long-term efficiency?

6. Finally, tell me about the ***importance of education*** to Cameroonians generally.
   - How important is education to Cameroonians?
   - What role does mathematics education play in achieving the goals of educating Cameroonians in the 21st Century?
   - Why do educational systems in Africa in general, and Cameroon in particular remain incapable of providing the skills required for economic, technological and scientific development?

1. What is your definition of *mathematics*?

2. If you were asked to design the cover of a mathematics text, what would it look like?

3. Mathematics has been described by some as *a theoretical subject divorced from its human origins*. How would you respond to such a description?

4. How would you respond to the following statements?

a) Different cultures and the course of history have contributed to mathematics.

b) Mathematics exist as *pre-given* knowledge i.e. mathematics knowledge is not created. We merely recognize relationships that have been there before mankind.

c) Mathematics is logically derived from axioms.

5. How often do you present a historical background to the mathematics you teach?

Never	Rarely	Sometimes	Regularly	All the time
☐	☐	☐	☐	☐

6. How often do you present a cultural background to the mathematics you teach?

Never	Rarely	Sometimes	Regularly	All the time
☐	☐	☐	☐	☐

Please Turn Over

7. How important are students' everyday experiences in their learning of mathematics?

Not Important	Slightly Important	Important	Very Important	Crucial
☐	☐	☐	☐	☐

8. How relevant are students' everyday experiences in your planning of mathematics instructions?

Not Relevant	Slightly Relevant	Relevant	Very Relevant	Crucial
☐	☐	☐	☐	☐

9. How relevant is one's cultural background to the way one learns mathematics?

Not Relevant	Slightly Relevant	Relevant	Very Relevant	Crucial
☐	☐	☐	☐	☐

10. Can teachers use students' *in-school* and *out-of-school* experiences to connect mathematics learning and practices in these contexts? If so, how? If not, why not?

11. Do you expect your students to know mathematics which they were not explicitly taught?

☐ Yes ☐ No

If so, why? If not, why not?

12. What role does a mathematics education play in the educational development of Cameroon?

_____

_____

_____

_____

_____

13. How often do you develop mathematical concepts on the basis of problems present in real-life contexts?

Never	Rarely	Sometimes	Regularly	All the time
☐	☐	☐	☐	☐

14. How important are the following qualities when deciding on a **mathematics text**?

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) Correctness of the content,	☐	☐	☐	☐	☐
b) Adaptation to students' abilities,	☐	☐	☐	☐	☐
c) Preparation of the students for the text by what they have already learned,	☐	☐	☐	☐	☐
d) Preparation for what they would have to learn in the future,	☐	☐	☐	☐	☐
e) Relevance to the national examinations.	☐	☐	☐	☐	☐

15. To what extent would you agree or disagree with the following statements?

	Strongly Disagree 0	Disagree 1	Neutral 2	Agree 3	Strongly Agree 4
a) The mathematics curriculum should be seen by pupils as relevant to their future lives,	☐	☐	☐	☐	☐
b) The mathematics curriculum should incorporate elements of the cultural histories of all the people of the region,	☐	☐	☐	☐	☐

c) The mathematics curriculum should be experienced as "real" by all children,	☐	☐	☐	☐	☐
d) The mathematics curriculum should resonate, as far as possible, with diverse home cultures.	☐	☐	☐	☐	☐

---

16. How important are the opinions of the following when deciding on an official mathematics text for secondary schools?

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) Ministry of national education,	☐	☐	☐	☐	☐
b) National Examination boards,	☐	☐	☐	☐	☐
c) University mathematics faculty,	☐	☐	☐	☐	☐
d) Pedagogic adviser for mathematics,	☐	☐	☐	☐	☐
e) Secondary mathematics teacher,	☐	☐	☐	☐	☐
f) Students,	☐	☐	☐	☐	☐
g) Parents.	☐	☐	☐	☐	☐

---

17. How important are opinions of the following in the evaluation of secondary school student learning?

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) Ministry of national education,	☐	☐	☐	☐	☐
b) National Examination boards,	☐	☐	☐	☐	☐
c) University mathematics faculty,	☐	☐	☐	☐	☐
d) Pedagogic adviser for mathematics,	☐	☐	☐	☐	☐
e) Secondary mathematics teacher,	☐	☐	☐	☐	☐
f) Students,	☐	☐	☐	☐	☐
g) Parents.	☐	☐	☐	☐	☐

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18. If you were charged with developing a mathematics curriculum for schools in Cameroon, how important will the opinions of the following be in deciding on what goes into the curriculum document?

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) Ministry of national education,	☐	☐	☐	☐	☐
b) National Examination boards,	☐	☐	☐	☐	☐
c) University mathematics faculty,	☐	☐	☐	☐	☐
d) Pedagogic adviser for mathematics,	☐	☐	☐	☐	☐
e) Secondary mathematics teacher,	☐	☐	☐	☐	☐
f) Students,	☐	☐	☐	☐	☐
g) Parents.	☐	☐	☐	☐	☐

19. If you were charged with developing a mathematics curriculum for schools in Cameroon, how important are the following:

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) gaining experience of problem solving,	☐	☐	☐	☐	☐
b) gaining experience of problem posing,	☐	☐	☐	☐	☐
c) math processes are more important than products,	☐	☐	☐	☐	☐
d) making use of communicative skills,	☐	☐	☐	☐	☐

20. What do you think **ethnomathematics** means?

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21. How do you feel about an *ethnomathematical foundation* being incorporated into the mathematics curriculum for schools in Cameroon?

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Please Turn Over

22. What effects will an *ethnomathematical foundation* to the curriculum have on national examinations like the G.C.E and Baccalaureate?

23. What sort of changes will need to be in place for such an *ethnomathematical foundation* to be implemented?

24. *"Mathematical knowledge is essentially unhistorical. Therefore one can always link the mathematics accomplished in some particular historical period with the mathematics of today without worrying at all about the historical or cultural context in which the mathematics has developed."* How would you respond to such assertions?

25. There are some who would argue that "mathematics is a *culture-bound* discipline" i.e. every culture has its own mathematics developed over the years. How would you respond to such an argument in the context of Cameroon?

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26. To what extent do you agree or disagree with the following statements?

	Strongly Disagree 0	Disagree 1	Neutral 2	Agree 3	Strongly Agree 4
a) Using technologies in mathematics lessons will improve students' understanding of mathematics.	☐	☐	☐	☐	☐
b) Problem solving should be the central focus of mathematics learning.	☐	☐	☐	☐	☐
c) Learning the history of the evolution of mathematics concepts should be a major objective of mathematics education.	☐	☐	☐	☐	☐
d) Identifying the connections between formal mathematics and mathematics in everyday situations should be a major role of the mathematics teacher.	☐	☐	☐	☐	☐

27. What mathematics should be taught to Cameroonian children? Why?

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Thank you very much for your participation. Your contributions to this research will be considered in the final report on making mathematics more interesting to students in Cameroon and other developing countries.

1. What is your definition of *mathematics*?

2. If you were asked to design the cover of a mathematics text, what would it look like? You can either draw or list the things you would put on the cover.

3. Mathematics has been described by some as a theoretical subject divorced from its human origins. How would you respond to such a description?

4. How would you respond to the following statements?
   a) Different cultures and the course of history have contributed to mathematics.

b) Mathematics exist as pre-given knowledge. i.e. mathematics knowledge cannot be created but exist independent of mankind.

c) Mathematics is logically derived from axioms.

5. How often should teachers present a historical background to the mathematics they teach?

Never	Rarely	Sometimes	Regularly	All the time
☐	☐	☐	☐	☐

6. How often should teachers present a cultural background to the mathematics they teach?

Never	Rarely	Sometimes	Regularly	All the time
☐	☐	☐	☐	☐

7. How important are students' everyday experiences in their learning of mathematics?

Not Important	Slightly Important	Important	Very Important	Crucial
☐	☐	☐	☐	☐

8. How relevant should students' everyday experiences be in the planning of mathematics instructions?

Not Relevant	Slightly Relevant	Relevant	Very Relevant	Crucial
☐	☐	☐	☐	☐

Please Turn Over

9. How relevant is one's cultural background to the way one learns mathematics?

Not Relevant	Slightly Relevant	Relevant	Very Relevant	Crucial
☐	☐	☐	☐	☐

10. Can teachers use students' *in-school* and *out-of-school* experiences to connect mathematics learning and practices in these contexts?

☐ Yes ☐ No

If so, how? If not, why not?

11. Do teachers expect students to know mathematics which they were not explicitly taught?

☐ Yes ☐ No

If so, why? If not, why not?

12. What role does a mathematics education play in the educational development of Cameroon?

13. In your advice to teachers, how often do you develop mathematical concepts on the basis of problems present in real-life contexts?

Never	Rarely	Sometimes	Regularly	All the time
☐	☐	☐	☐	☐

14. How important are the following qualities when deciding on a **mathematics text**?

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) Correctness of the content,	☐	☐	☐	☐	☐
b) Adaptation to students' abilities,	☐	☐	☐	☐	☐
c) Preparation of the students for the text by what they have already learned,	☐	☐	☐	☐	☐
d) Preparation for what they would have to learn in the future,	☐	☐	☐	☐	☐
e) Relevance to the national examinations.	☐	☐	☐	☐	☐

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15. To what extent do you agree or disagree with the following statements?

	Strongly Disagree 0	Disagree 1	Neutral 2	Agree 3	Strongly Agree 4
a) The mathematics curriculum should be seen by pupils as relevant to their future lives,	☐	☐	☐	☐	☐
b) The mathematics curriculum should incorporate elements of the cultural histories of all the people of the region,	☐	☐	☐	☐	☐
c) The mathematics curriculum should be experienced as "real" by all children,	☐	☐	☐	☐	☐
d) The mathematics curriculum should resonate, as far as possible, with diverse home cultures.	☐	☐	☐	☐	☐

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16. How important are the opinions of the following when deciding on an official mathematics text?

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) Ministry of national education,	☐	☐	☐	☐	☐
b) National Examination boards,	☐	☐	☐	☐	☐
c) University mathematics faculty,	☐	☐	☐	☐	☐
d) Pedagogic adviser for mathematics,	☐	☐	☐	☐	☐

Please Turn Over

e) Secondary mathematics teacher,	☐	☐	☐	☐	☐
f) Students,	☐	☐	☐	☐	☐
g) Parents.	☐	☐	☐	☐	☐

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17. How important are opinions of the following in the evaluation of student learning?

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) Ministry of national education,	☐	☐	☐	☐	☐
b) National Examination boards,	☐	☐	☐	☐	☐
c) University mathematics faculty,	☐	☐	☐	☐	☐
d) Pedagogic adviser for mathematics,	☐	☐	☐	☐	☐
e) Secondary mathematics teacher,	☐	☐	☐	☐	☐
f) Students,	☐	☐	☐	☐	☐
g) Parents.	☐	☐	☐	☐	☐

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18. If you were charged with developing a mathematics curriculum for schools in Cameroon, how important will the opinions of the following be in deciding on what goes into the curriculum document?

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) Ministry of national education,	☐	☐	☐	☐	☐
b) National Examination boards,	☐	☐	☐	☐	☐
c) University mathematics faculty,	☐	☐	☐	☐	☐
d) Pedagogic adviser for mathematics,	☐	☐	☐	☐	☐
e) Secondary mathematics teacher,	☐	☐	☐	☐	☐
f) Students,	☐	☐	☐	☐	☐
g) Parents.	☐	☐	☐	☐	☐

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19. If you were charged with developing a mathematics curriculum for schools in Cameroon, how important are the following as goals for students learning of mathematics?

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) gaining experience of problem solving,	☐	☐	☐	☐	☐
b) gaining experience of problem posing,	☐	☐	☐	☐	☐
c) math processes are more important than products,	☐	☐	☐	☐	☐
d) making use of communicative skills,	☐	☐	☐	☐	☐

20. What do you think **ethnomathematics** means?

21. How do you feel about an *ethnomathematical foundation* being incorporated into the mathematics curriculum for schools in Cameroon?

22. What sort of changes will need to be in place for such an *ethnomathematical foundation* to be implemented?

Please Turn Over

23. What effects will an *ethnomathematical foundation* to the curriculum have on national examinations like the G.C.E and Baccalaureate?

24. What effects will an *ethnomathematical foundation* to the curriculum have on the training of secondary mathematics teachers in Cameroon?

25. *"Mathematical knowledge is essentially unhistorical. Therefore one can always link the mathematics accomplished in some particular historical period with the mathematics of today without worrying at all about the historical or cultural context in which the mathematics has developed."* How would you respond to such assertions?

26. There are some who would argue that "mathematics is a *culture-bound* discipline" i.e. every culture has its own mathematics developed over the years. How would you respond to such an argument in the context of Cameroon?

27. To what extent do you agree or disagree with the following statements?

	Strongly Disagree 0	Disagree 1	Neutral 2	Agree 3	Strongly Agree 4
e) Using technologies in mathematics lessons will improve students' understanding of mathematics.	☐	☐	☐	☐	☐
f) Problem solving should be the central focus of mathematics learning.	☐	☐	☐	☐	☐
g) Learning the history of the evolution of mathematics concepts should be a major objective of mathematics education.	☐	☐	☐	☐	☐
h) Identifying the connections between formal mathematics and mathematics in everyday situations should be a major role of the mathematics teacher.	☐	☐	☐	☐	☐

28. What mathematics should be taught to Cameroonian children? Why?

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Thank you very much for your participation. Your contributions to this research will be considered in the final report on making mathematics more interesting to students in Cameroon and other developing countries.

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4. How would you respond to the following statements?
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b) Mathematics exist as pre-given knowledge. i.e. mathematics knowledge cannot be created but exist independent of mankind.

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c) Mathematics is logically derived from axioms.

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5. How often do you present a historical background to the mathematics you teach?

Never	Rarely	Sometimes	Regularly	All the time
☐	☐	☐	☐	☐

6. How often do you present a cultural background to the mathematics you teach?

Never	Rarely	Sometimes	Regularly	All the time
☐	☐	☐	☐	☐

7. How important are students' everyday experiences in their learning of mathematics?

Not Important	Slightly Important	Important	Very Important	Crucial
☐	☐	☐	☐	☐

8. How relevant are students' everyday experiences in your planning of mathematics instructions?

Not Relevant	Slightly Relevant	Relevant	Very Relevant	Crucial
☐	☐	☐	☐	☐

Please Turn Over

9. How relevant is one's cultural background to the way one learns mathematics?

Not Relevant	Slightly Relevant	Relevant	Very Relevant	Crucial
☐	☐	☐	☐	☐

10. Can teachers use students' *in-school* and *out-of-school* experiences to connect mathematics learning and practices in these contexts?

☐ Yes ☐ No

If so, how? If not, why not?

11. Do teachers expect students to know mathematics which they were not explicitly taught?

☐ Yes ☐ No

If so, why? If not, why not?

12. What role does a mathematics education play in the educational development of Cameroon?

13. How often do you develop mathematical concepts on the basis of problems present in real-life contexts?

Never	Rarely	Sometimes	Regularly	All the time
☐	☐	☐	☐	☐

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14. How important are the following qualities when deciding on a **mathematics text**?

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) Correctness of the content,	☐	☐	☐	☐	☐
b) Adaptation to students' abilities,	☐	☐	☐	☐	☐
c) Preparation of the students for the text by what they have already learned,	☐	☐	☐	☐	☐
d) Preparation for what they would have to learn in the future,	☐	☐	☐	☐	☐
e) Relevance to the national examinations.	☐	☐	☐	☐	☐

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15. To what extent do you agree or disagree with the following statements?

	Strongly Disagree 0	Disagree 1	Neutral 2	Agree 3	Strongly Agree 4
a) The mathematics curriculum should be seen by pupils as relevant to their future lives,	☐	☐	☐	☐	☐
b) The mathematics curriculum should incorporate elements of the cultural histories of all the people of the region,	☐	☐	☐	☐	☐
c) The mathematics curriculum should be experienced as "real" by all children,	☐	☐	☐	☐	☐
d) The mathematics curriculum should resonate, as far as possible, with diverse home cultures.	☐	☐	☐	☐	☐

Please Turn Over

16. How important are the opinions of the following when deciding on an official mathematics text?

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b) National Examination boards,	☐	☐	☐	☐	☐
c) University mathematics faculty,	☐	☐	☐	☐	☐
d) Pedagogic adviser for mathematics,	☐	☐	☐	☐	☐
e) Secondary mathematics teacher,	☐	☐	☐	☐	☐
f) Students,	☐	☐	☐	☐	☐
g) Parents.	☐	☐	☐	☐	☐

17. How important are opinions of the following in the evaluation of student learning?

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) Ministry of national education,	☐	☐	☐	☐	☐
b) National Examination boards,	☐	☐	☐	☐	☐
c) University mathematics faculty,	☐	☐	☐	☐	☐
d) Pedagogic adviser for mathematics,	☐	☐	☐	☐	☐
e) Secondary mathematics teacher,	☐	☐	☐	☐	☐
f) Students,	☐	☐	☐	☐	☐
g) Parents.	☐	☐	☐	☐	☐

18. If you were charged with developing a mathematics curriculum for schools in Cameroon, how important are the following:

	Not Important 0	Slightly Important 1	Important 2	Very Important 3	Crucial 4
a) gaining experience of problem solving,	☐	☐	☐	☐	☐
b) gaining experience of problem posing,	☐	☐	☐	☐	☐
c) math processes are more important than products,	☐	☐	☐	☐	☐
d) making use of communicative skills,	☐	☐	☐	☐	☐

19. What do you think **ethnomathematics** means?

20. How do you feel about an *ethnomathematical foundation* being incorporated into the mathematics curriculum for schools in Cameroon?

21. What sort of changes will need to be in place for such an *ethnomathematical foundation* to be implemented?

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Please Turn Over

23. *"Mathematical knowledge is essentially unhistorical. Therefore one can always link the mathematics accomplished in some particular historical period with the mathematics of today without worrying at all about the historical or cultural context in which the mathematics has developed."* How would you respond to such assertions?

24. There are some who would argue that "mathematics is a *culture-bound* discipline" i.e. every culture has its own mathematics developed over the years. How would you respond to such an argument in the context of Cameroon?

25. To what extent do you agree or disagree with the following statements?

	Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
	0	**1**	**2**	**3**	**4**
a) Using technologies in mathematics lessons will improve students' understanding of mathematics.	☐	☐	☐	☐	☐
b) Problem solving should be the central focus of mathematics learning.	☐	☐	☐	☐	☐
c) Learning the history of the evolution of mathematics concepts should be a major objective of mathematics education.	☐	☐	☐	☐	☐
d) Identifying the connections between formal mathematics and mathematics in everyday situations should be a major role of the mathematics teacher.	☐	☐	☐	☐	☐

26. What mathematics should be taught to Cameroonian children? Why?

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- END -

Thank you very much for your participation. Your contributions to this research will be considered in the final report on making mathematics more interesting to students in Cameroon and other developing countries.

1. When you hear the word ***mathematics*** what immediately comes to your mind?

2. If you were asked to design the cover of a mathematics textbook, what would it look like?

3. Which of the following is/are reason(s) for learning mathematics? (Circle all the reasons that apply to you.)
   a) Passport or ticket to success and security in life,
   b) Admiration and recognition in society as mathematically talented,
   c) Mathematical knowledge is useful in life,
   d) Mathematics is compulsory in schools,
   e) Mathematics is present in all public examinations.

4. What can be done to make mathematics more 'interesting' to you?

5. Do students know mathematics which they were not explicitly taught? ❑ Yes ❑ No

If so, how? If not, why not?

6. How valid is the following statement:
'Getting the correct answer to a mathematics problem is more important than understanding the mathematics process.'?

❑ True ❑ False

7. In what situations do you use mathematics? List as many as possible.

8. How often do you use mathematics in your daily life?

Never	Rarely	Sometimes	Regularly	All the time
❑	❑	❑	❑	❑

9. Is **history** and **mathematics** related in any way? ❑ Yes ❑ No

If so, how? If not, why not?

Please Turn Over

10. Should mathematics remain a compulsory subject at the secondary school?

❑ Yes ❑ No

If so, why? If not, why not?

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11. Which of the following statements best represent your present feelings about mathematics. (*Circle all that apply to you.*)

a) Mathematics is my best subject in school.
b) I don't like mathematics.
c) Doing mathematics is my favourite activity.
d) Mathematics is very boring.
e) When I start solving a mathematics problem, I persist until I arrive at the right solution.

12. Could you tell what you feel when trying to solve a mathematics problem? (*For each statement, please put an 'X' in the answer that best expresses your feelings*)

	Partly False	**False**	**Don't Know**	**Partly True**	**True**
a) I feel there is something that keeps me from getting at the problem, a sort of barrier I can't get across.	❑	❑	❑	❑	❑
b) I feel that I am creating something when I am solving a problem.	❑	❑	❑	❑	❑
c) When I start, I feel completely in the dark.	❑	❑	❑	❑	❑
d) When confronted with a problem, I want to give up right away.	❑	❑	❑	❑	❑
e) If I find the solution right away, I feel really proud.	❑	❑	❑	❑	❑
f) I feel like I am merely wasting my time.	❑	❑	❑	❑	❑

13. Could you tell what doing mathematics means to you? (*For each statement, please put an 'X' in the answer that best expresses your feelings*)

	Partly False	False	Don't Know	Partly True	True
a) It does not mean anything, it is nonsense.	❑	❑	❑	❑	❑
b) It is doing something that you are told to do and that you have to keep doing over and over, like a machine.	❑	❑	❑	❑	❑
c) It is doing something which I think I just cannot do.	❑	❑	❑	❑	❑
d) It is constantly discovering something new.	❑	❑	❑	❑	❑
e) It is trying to find connections between different things.	❑	❑	❑	❑	❑

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14. Indicate what you think of the following sentences (*For each statement, please place an 'X' in the box that best expresses your feelings*):

	Partly False	False	Don't Know	Partly True	True
a) When you do mathematics, there is no room for personality. Everything you do has been done before, everything has been planned.	❑	❑	❑	❑	❑
b) Mathematics gives you the pleasure of creating something.	❑	❑	❑	❑	❑
c) Mathematics means another world in which I feel at home.	❑	❑	❑	❑	❑
d) Mathematics allows you to develop good reasoning.	❑	❑	❑	❑	❑
e) Those who do too much mathematics risk losing touch with reality.	❑	❑	❑	❑	❑

Please Turn Over

15. Do you find **mathematics** in your **culture** in any way? ☐ Yes ☐ No

If so, give some examples? If not, why not?

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- END -

Thank you very much for your participation. Your contributions to this research will be considered in the final report on making mathematics more interesting to students in Cameroon and other developing countries.

Appendix B

THE ETHNOMATHEMATICS UNIT

The purpose of this research project was to assess the receptiveness to an ethnomathematics foundation to the secondary mathematics curriculum and not the teaching of the ethnomathematics unit. Hence the unit was intended to give the stakeholders an idea of what ethnomathematics was all about. The activities found here are excerpts of the lesson activities used in the unit and are listed here for illustrative purposes only. The actual unit was intended to run for four weeks covering topics needed to be covered for that period with Form 2 (Grade 8/9) students. The teachers were given the flexibility to organize the lesson activities to suite their teaching approaches and their classroom setup.

The activities listed here comprise four Cameroonian games which were used to teach the various concepts according to the scheme of work for Form 2 during that time period. Also included are four lesson plans that were used for the teaching of some topics in geometry. Again, these are for illustrative purposes only.

SOME CAMEROONIAN GAMES AND THE MATHEMATICS IN THEM

I. THE GAME OF PEBBLES

The game of pebbles is most conveniently played by 2 to 6 persons. All that is required is a good amount of pebbles, about a handful per player. At the start of the game, the players sit on a very low stool or on the floor, in a small circle, as in Fig. 1. The heap of pebbles is placed in front of A, the person who begins the game. He begins by collecting as many of the pebbles in his/her cupped hands, and throws the pebbles upwards. As soon as the pebbles are out of his/her hands, s/he inverts his/her palms so as to intercept a convenient number of the falling pebbles with the back of his/her hands. When the rest of the pebbles have fallen on the floor, s/he throws upwards as before, all the pebbles on the back of his/her hands and this time s/he has to catch all the pebbles with his/her cupped palms. Should one or more pebbles drop in his/her attempt to catch them, or should s/he shake or touch any of the pebbles on the floor with his/her hands or any part of his/her body, s/he immediately loses his/her turn, and hands over to the next player, B, all the pebbles in his/her hands and on the floor.

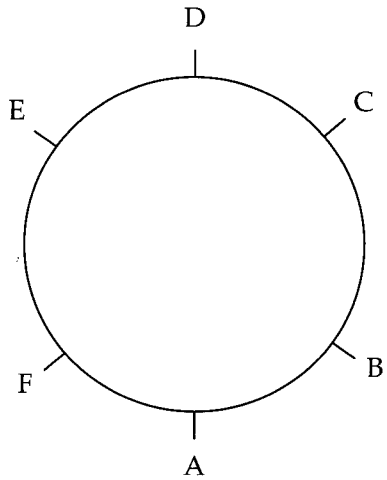

Fig. 1: Sitting Positions

Granted that the player has successfully caught all the pebbles in the second throw, Fig. 2 shows the scene at this stage: a small heap of pebbles **X** caught in the second throw, and the rest of the pebbles **Y** scattered on the floor. The player now takes a pebble from **X**, throws it up onto a convenient height, and while the pebble is in mid-air, s/he carefully picks one or more pebbles from **Y** and then catches the falling pebble, so that s/he now has two or more pebbles in the hand. All this is done with one hand only. S/he repeats this process with every one of the pebbles in heap **X**, and creates a third heap besides him/her, which s/he calls his/her *gains*. However, as soon as s/he touches or shakes one or more of the pebbles in the heap **Y**, or fails to catch the falling pebble, s/he loses his/her turn and hands over to the next player, all the pebbles except his/her gains. Normally, his/her

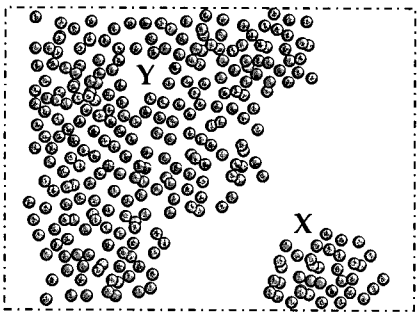

Fig. 2: Pebbles Placement

turns ends when s/he has used up all the pebbles in **X**. S/he then hands to the next player the rest of the pebbles in **Y**.

The next player B then goes over the above two stages of the game, and hands over to C the balance of the pebbles not gained. Each player tries to gain as many pebbles as possible. The game ends when there are no more pebbles left, that is when all the pebbles have been gained. Everybody counts his/her gains, and the winner is the player with maximum gains.

Mathematical Aspects of the Game

1. *Natural Numbers*

The game of pebbles is basically a 'counting game'. At the end of a player's turn, s/he immediately counts his/her gains, and is happy if they are many. At the end of the game, all the players count their gains to ascertain the order or merit. The person with the greatest gains is the winner. The game therefore fosters skills in counting, a value asset to young children.

2. *Order in* $\mathbb{N}$

A notion is acquired of the concepts: 'is greater than', 'is less than', 'is equal', which are fundamental notions in algebra. First, there is an intuitive feeling of these concepts; when a player has had his/her turn, s/he counts his/her gains and mentally compares it with those of his/her friends. Anybody with a larger heap than his/hers, obviously has gained more. At the end of a game, after the general count, if the order or merit of the players is: A, E, C, D, B, F, then E knows that his/her gains are 'greater than' C's, and 'less than' A's. Where there is a tie, the gains are 'equal'.

3. *Operations of Addition*

The basic operation of addition is encountered in many forms. Most rudimentary is the '1 + 1 = 2' type, when, at the second stage of a player's turn, each pebble thrown up wins one or more pebbles on the floor, if successfully caught. If the game is long enough to go round two or more times, then to the gains in the previous round, each player adds the gains in the new round. Here more skills in addition are achieved.

4. *Notion of Zero*

An intuitive notion of the significance of zero is also learnt. If an unfortunate player happens to touch or shake any pebble before gaining something, s/he has a zero gain, i.e. no gain. Should this occur in the second round after s/he had gained N pebbles, say, then his/her total gains is unchanged, that is, N + 0 = N.

5. *Introductory Set Theory*

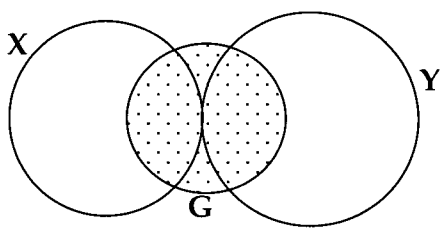

Fig. 3

In the course of a player's turn, the pebbles on play can be divided into three sets **X** and **Y** as in Fig. 2 above, and **G** his/her gains. The relationship between these sets is shown in the Venn diagram in Fig. 3. In set algebra, the relationship is as follows:

$$\mathbf{X} \cap \mathbf{Y} = \varnothing; \quad \mathbf{G} \subset (\mathbf{X} \cup \mathbf{Y}).$$

It should be noted that G is made up of two subsets observing the relation

$$\mathbf{G} \cap \mathbf{X} \leq \mathbf{G} \cap \mathbf{Y}.$$

The equality holds when pebbles are gained from **Y** in singles. If a player is fortunate to gain all the pebbles (which occasionally happens with very skilled players), then

$$\mathbf{G} = \mathbf{X} \cup \mathbf{Y},$$

but if an unfortunate player has gained nothing, then,

$$\mathbf{G} = \mathbf{X} \cap \mathbf{Y} = \varnothing$$

II. THE GAME OF SEVENS

This game, which is somehow similar to the game of pebbles, is played with only 7 pebbles. Any number of players may take part in the game. All the players sit or squat in a circle, as in the game of pebbles.

The first player takes all the 7 pebbles in one hand and throws them on the floor, thereby scattering them. S/he then carefully picks up one of the pebbles without touching or shaking any of the remaining 6. S/he throws up this pebble and while it is in mid-air, s/he carefully picks up one of the 6 pebbles on the floor and catches the falling pebble, all with one hand. S/he would then have 2 pebbles in his/her hand, and 5 on the floor. S/he places down besides him/her one of the two pebbles in his/her hand, and throws up the other. While this is up, s/he again picks up one of the 5 pebbles on the floor and with the same hand catches the falling pebble. This process is repeated until all the pebbles on the floor are taken. This completes the first stage of the game.

From the time the player throws down the 7 pebbles till s/he catches the last pebble, should s/he touch or shake any of the pebbles on the floor with his/her hands or any part of his/her body, s/he immediately loses his/her turn, and hands all the 7 pebbles to the next player, usually in an anti-clockwise direction.

If the player successfully catches all the 6 pebbles, one-at-a-time, s/he is qualified to enter the second stage. S/he again throws down all the 7 pebbles, and again selects one. This time when s/he throws up this pebble, s/he has to pick up 2 of the 6 pebbles on the floor, and catch the falling pebble. If this is successfully done, s/he places 2 down besides him/her, throws up the third, picks up 2 from the remaining 4, catches the falling one, all with one hand, and without shaking the 2 remaining pebbles still in play. This two-at-a-time stage of the game is completed in three throws.

The third stage is to pick up the pebbles three-at-a-time. Here there would be only two throws. In the fourth stage, the player again throws down all the 7 pebbles, selects one, and throws it up. While this is up, s/he picks up 2 pebbles from the floor and catches the falling pebble, leaving 4 pebbles on the floor. In the next throw, the player has to pick up all the remaining 4 pebbles on the floor. Otherwise, the player may choose to pick up 4 in his/her first throw and the remaining 2 in the second throw.

In the fifth stage, there are also two throws. The player may decide to pick up one pebble in the first throw and 5 in the second, or 5 in the first and one in the second, depending on whichever is more convenient.

In the sixth and final stage, the player holds the 7 pebbles in one hand, throws up one of these, and while it is in mid-air he places down carefully the 6 in his/her hand and then catches the falling pebble. Then he throws this single pebble up again, carefully collects the 6 which s/he placed down, and catches the falling pebble.

The player who successfully completes these 6 stages has won a game. S/he then hands over the 7 pebbles to the next player. If a player commits a fault (by touch or shaking a pebble still in play) at any stage of the game, s/he loses his/her turn, and hands over all the pebbles, and no points are awarded no matter how far s/he had progressed in the game. The game ends when the players are tired; the person who has won the greatest number of individual games is the over-all winner.

Mathematical Aspects of the Game

1. This game basically teaches the number 6. We can look at 6 as:

Six units:	$6 = 1 + 1 + 1 + 1 + 1 + 1$
Three two's:	$6 = 2 + 2 + 2$
Two three's:	$6 = 3 + 3$
The sum of four and two:	$6 = 4 + 2$
The sum of five and one:	$6 = 5 + 1$

2. This game also teaches that *addition is commutative*, for:

   $4 + 2 = 2 + 4$; $5 + 1 = 1 + 5$

3. It shows the relation between multiplication and addition i.e. *multiplication is continuous addition*:

   $2 + 2 + 2 = 2 \times 3$ (Three two's is the same as two, three times)

   $3 + 3 = 3 \times 2$ (Two three's is the same as three, twice)

4. It also shows that multiplication is commutative:

   $2 \times 3 = 3 \times 2$

5. And it brings out the idea of division, and factors:

   6 can be divided exactly into 3 parts: $6 \div 3 = 2$;

   and exactly into 2 parts: $6 \div 2 = 3$.

III. TUMBU TUMBU or THE GAME OF WHODUNIT

This game is played either to find out who has done a certain mischief, or to cast lots for one person to carry out an assignment. The suspects, or those drawing the lot, stand in a circle and the leader recites the following ditty:

Tumbu	tumbu	bes	kalabar	titi	abanda	bos,
1	2	3	4	5	6	7
Abanda	banda	kai	kai ka	titi	abanda	tos!
8	9	10	11	12	13	14

The above is recited so that the numbering, as indicated on special syllables, correspond to a beat (there is a short pause of one beat at the end of the first line). As the leader recites this, he points to a different player with his index finger at each beat, round the group. The person on whom the last beat falls is the one who did it, or on whom the lot has fallen.

The leader, who is usually the eldest member (or the bully), has the prerogative to start with whomsoever s/he pleases, and from that person s/he moves round the group in a definite direction. S/he always ensures, of course, that the last beat never falls on himself/herself. Thus if there are only two players, s/he invariably starts with himself/herself, knowing that he will capture all the odd beats, leaving the even beats, and the last which is the 14th, to his victim. If on the other hand there is a pleasurable assignment to be done, the leader would start with his opponent, so that s/he the leader, will draw the lot!

It is generally known that the results of this game are not reliable, and they are never taken seriously; but children derive much fun out of it.

Mathematical Aspects of the Game

This game is an intuitive approach to modular arithmetic. The following tables in Fig. 4 show the distribution of the beats when 2 to 5 persons are involved. Let the players be named: A, B, C, D, E, where A is the leader.

Two Players:

A	1	3	5	7	9	11	13
B	2	4	6	8	10	12	14

Three Players:

A	1	4	7	10	13
B	2	5	8	11	14
C	3	6	9	12	

Four Players:

A	1	5	9	13
B	2	6	10	14
C	3	7	11	
D	4	8	12	

Five Players:

A	1	6	11
B	2	7	12
C	3	8	13
D	4	9	14
E	5	10	

Fig. 4: Distribution of Beats

The subtle plot in the game, when it is the case of finding 'who done it', is to make the leader never end up with the last beat, and also to make the general suspect have the last beat. In the case of drawing lots, the plot would be to have the lot fall on the least favourable member of the group if it is an unpleasant task, or to have it fall on the leader or his/her favourite person, if it is a pleasant task. In general, the plot in the game is to make the last beat fall on a pre-determined person. And here is where the mathematics of modular arithmetic comes in. Since

$$14 \equiv 2 \pmod 3,$$

all the leader has to do, when there are three players, is to make his victim the second person. Similarly, when there are 4 players, the victims should also be second, since

$$14 \equiv 2 \pmod 4.$$

Therefore, having predetermined the victim, the leader starts the count from the person next to the victim. In case of 5 players, since

$$14 \equiv 4 \pmod 5,$$

the victim has to be the fourth person.

Smart children know these facts by observing repeated results; which really are applications of modular arithmetic. Clearly children can and do enjoy games in the mathematics classroom but initially it does require a great deal of preparation and testing to see which are appropriate. Having done that preparation they are a valuable resource that can be used repeatedly, sometimes with many classes.

IV. STRING GEOMETRY or THE GAME OF THE DIAMONDS

This game commonly played by Cameroonian children mainly for pleasure or pastime, teaches skills in weaving, knitting and identifying various geometrical shapes. The game is often played as a contest with any number of contestants. Each contestant brings his or her own string of convenient length. During the contest, contestants can stand, sit or take whatever configuration s/he feels comfortable. The contest begins with the construction of a 'one diamond' shape by each of the contestants. Each contestant, in any order, is given one opportunity to construct the geometric shape. While a contestant is constructing the geometric shape, the rest of the contestants either stand or sit to watch. If the contestants are many, then they usually will all sit to watch the contestant called upon to construct a geometric shape. A contestant must be able to construct and clearly display the geometric shape in the string. The contestant who is unable or fails to construct the 'one diamond' shape at her/his first attempt is automatically eliminated from the contest. When all the contestants have taken their turn, this completes the first stage.

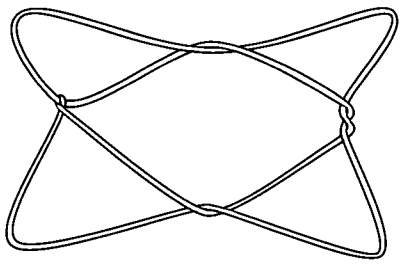

Fig. 1: One Diamond

All the contestants who were successful in constructing a 'one diamond' shape in the first stage qualify for the second stage. The second stage involves constructing a 'two diamond' shape. Each contestant is called upon, in any order, to construct the 'two diamond' shape at his/her first attempt. And similarly as in stage one, the contestants who are unable or fail to construct the 'two diamond' shape at their first attempt are automatically eliminated from the contest. When all the contestants have taken their turn, this completes stage two.

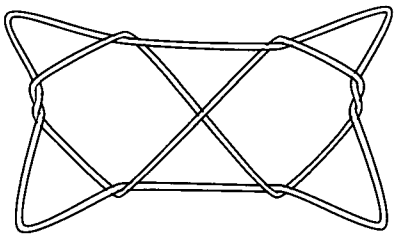

Fig. 2: Two Diamonds

All the contestants who were successful in constructing a 'two diamond' shape now move on to stage three. The contest continues until only one contestant is able to construct the geometric shape at a given stage. The contestant is then declared the overall winner of the contest. Contestants sometimes construct shapes as complex as a 'thirteen diamond' shape using "Rastafarian addition" (Stevenson & Murphy, 2002, p. 198).

Contestants benefit from reminders that practice makes perfect and that with practice, their hands will learn to dance smoothly as they form the geometric shape. Contestants

also quickly learn how to vary the design in the previous stage by twisting some or all the loops in the loom to generate the next geometric shape.

Mathematical Aspects of the Game

Constructing plane figures with the Diamond System[11]

"The Diamond system is a fairly simple suite of figures whose formation teaches a great deal about organizing effort and particularizing differences... Students push to create their own figures amazingly quickly once they pick up speed and begin to experience success in their teaching" (Stevenson & Murphy, 2002, p. 200). This system can be used to introduce computer language programming. "A successful experience with string figures can teach students to 'learn to learn' mathematics, as well as any other intellectual pursuit" (Stevenson & Murphy, 2002, p. 200). This game teaches students about modularity, subroutine and other computer programming language approaches.

1. *Construction Techniques*

Construction has always been considered a mathematical skill even before geometers declared that the quadrature of the circle, the duplication of the cube, and the trisection of a general angle were unsolvable construction problems. Working with the strings and constructing various geometric shapes gives students the opportunity to hone their skills in construction geometry. Students will eventually develop techniques in constructing *n*-diamonds when n is even or odd. Students can eventually record their observations in a table and this will help them conceptualise the whole diamond construction system.

2. *Conservation*

Students will learn that by starting with a 'two diamonds' shape, they can use the "storing two diamonds" (Stevenson & Murphy, 2002, p. 197) to construct other even diamonds shapes or shapes with higher number of diamonds. This iteration very useful in computer programming where, a result at one stage is stored and then retrieved later for subsequent use in the execution of the program.

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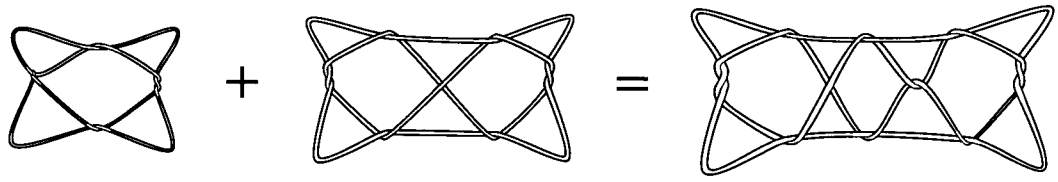
[11] For more on the "Diamond System" and how it can be used in the mathematics classroom see Stevenson and Murphy (2002), "Teaching Mathematics Skills with String Figures". In J. E. Hankes and G. R. Fast (Eds.), *Changing the Faces of Mathematics: Perspectives on Indigenous People of North America*, pp. 187-200. National Council of Teachers of Mathematics, Reston, Virginia.

3. *Operations in Addition*

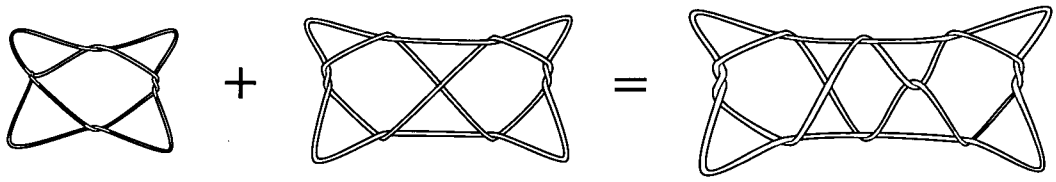
The children will come to observe that to construct, for example, a 'three diamonds' shape, they could begin by constructing a 'one diamond' shape and then adding a 'two diamonds' shape to it or by starting with a 'two diamonds' shape and then adding 'one diamond' shape to it.



One Diamond + Two Diamonds = Three Diamonds

4. *Commutativity of Addition*

Observing that a 'one diamond' shape plus a 'two diamonds' shape will result in 'three diamonds' shape or vice versa develops in the students the understanding that commutative property of addition.



One Diamond + Two Diamonds = Three Diamonds

5. *Multiplication as Continuous Addition*

If the game is able to continue to stages involving the construction of six or more diamonds shapes, the students will come to observe that to construct, for example, a 'six diamonds' shape, they will simply need to follow the steps in constructing a 'two diamond' shape and then repeating the steps twice. i.e. $6 = 2 + 2 + 2$. They may even be able to notice the possibility of constructing a 'six diamond' shape by repeating the steps in the construction of a 'three diamond' shape, although this may be a bit challenging to some students. i.e. $6 = 3 + 3$ and $6 = 2 + 2 + 2$.

6. *Pattern Recognition*

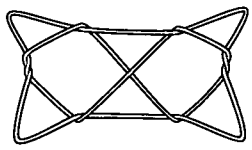
The power of mathematics lies in its ability to reduce complexity to controllable procedural patterns. Pattern recognition is a mathematical skill that will emerge from

the construction when students quickly notice that relationship in constructing even diamonds shapes starting with a 'two diamonds' shape and odd diamonds shapes by starting with a 'three diamond' shape.

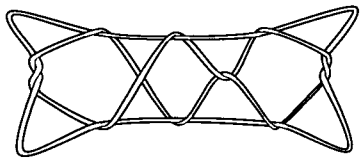
Exercise

Get students to establish the instructions to construct:

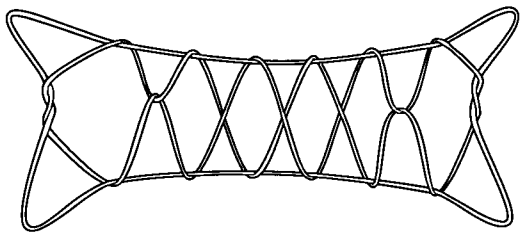
a) a two diamonds figure



b) a three diamonds figure



c) six diamonds figures



d) an odd number of diamonds

e) an even number of diamonds

The purpose of such an exercise is to develop in the students the ability to communicate mathematically and to communicate their mathematics to others. Above all, the teacher can use this string figure system to relax students when preparing, say for an exam.

Ethnomathematical Approach

The goal of an Ethnomathematical approach is to identify the sociocultural elements that teachers and curriculum developers should consider along with students' interest and motivation when planning instruction. Such a curriculum will help to raise the awareness in the students of the occurrence of mathematics in their surroundings and their daily lives. It is also the aim of ethnomathematics to get students to realize that mathematics is the contribution of cultures from time immemorial. To achieve this, the students must *participate* in identifying mathematical concepts around them, especially outside the mathematics classroom.

Role of the Teacher

In an Ethnomathematical approach to the teaching of mathematics, the duties of the teacher include but are not limited to the following:

- facilitating learning;
- making the connections between mathematical concepts in the classroom and their occurrence in everyday activities;
- raising the awareness of the students vis-à-vis the occurrence of mathematics in their cultural practices;
- using history of the development of mathematical thought to et students to understand and realize that all cultures mathematize, although not exactly in the same way;
- setting up activities for students to explore the development of various mathematical concepts and ideas;
- raising the students' interest and self-esteem toward mathematics;
- developing in the students, a sense of ownership of mathematics i.e. that mathematics is not a western invention but mankind's attempt to adapt to its environment;
- developing mathematical concepts through historical pathways such as the growth of mathematical thinking in various cultures;
- raising the self-concept of the students and letting them believe that they can contribute to the growing knowledge of mathematics; and
- getting students to learn mathematics for its own sake, for its beauty and not necessarily for its utilitarian aspects.

Ethnomathematical Infusion

By grounding knowledge in the local tradition and adapting, interpreting and creating classroom activities that retain vital connections with the culture, the context, and the indigenous language, ethnomathematics can serve as a bridge between a local indigenous culture and the larger society. The teacher should therefore be familiar with the occurrence of certain mathematical concepts within the students' surroundings. It is advisable for the teacher to explore these occurrences first in the students' cultures and then in other cultures, as this will help the students in understanding that mathematical ideas exist in every culture and are not the exclusive development of western societies.

Form: **Two**
Lesson #:
Duration: 45 – 50 Minutes

GEOMETRY

A. Congruent Plane Figures

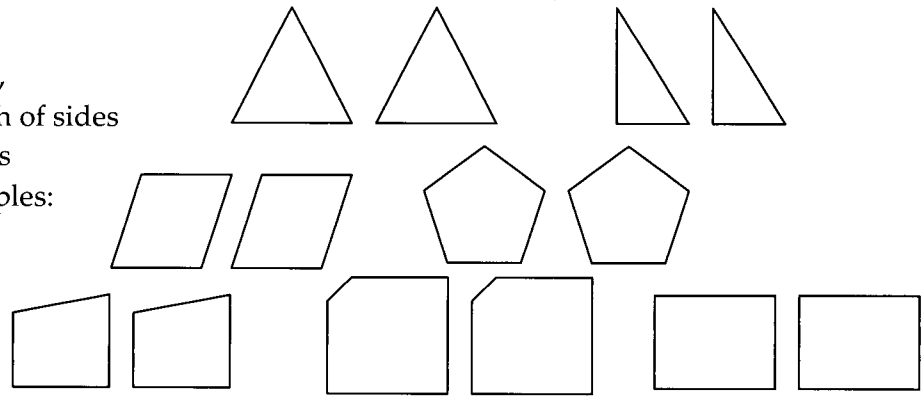
Introduction and Review

Review the definition of plane figures: A plane surface that has both length and breadth but no thickness.

Development

Ask students to name some plane figures: Triangles, Rectangles, Parallelograms, Polygons, etc.

Develop the notion of congruency in plane figures by drawing figures that have the same:
Size,
Shape,
Length of sides
Angles
Examples:

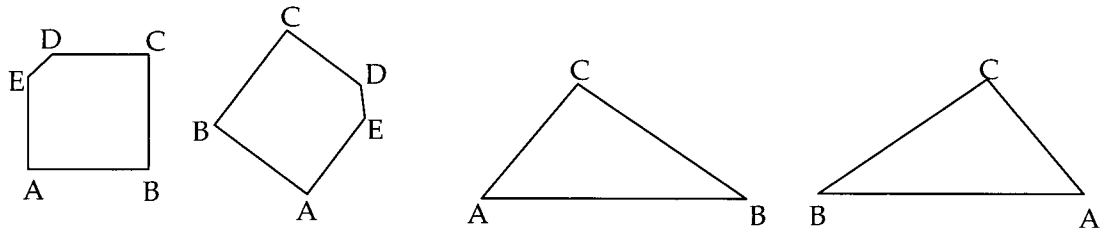


Get students to formalize the meaning of congruency in plane figures:

Whenever two or more figures have the same ***size*** *and* ***shape****, they are called congruent figures.*

Notation for congruence $\cong$

Note that when two figures are congruent, their congruency cannot be altered by rotation, translation, or reflection.



Ethnomathematical Dimension

1. Where do these figures occur in real life? e.g. knitting, embroidery, tessellations, reflections, weaving, crafts, etc.
   a) How do you think these congruent plane figures are created?
   b) Do you think the people who create these congruent figures have any knowledge of geometry, congruency, etc.

2. What are some of their uses to us? e.g. beauty, decoration, replication, mass production, etc.

3. Why are they important to us i.e. why do we need to know that two figures are congruent?

B. Congruent Triangles

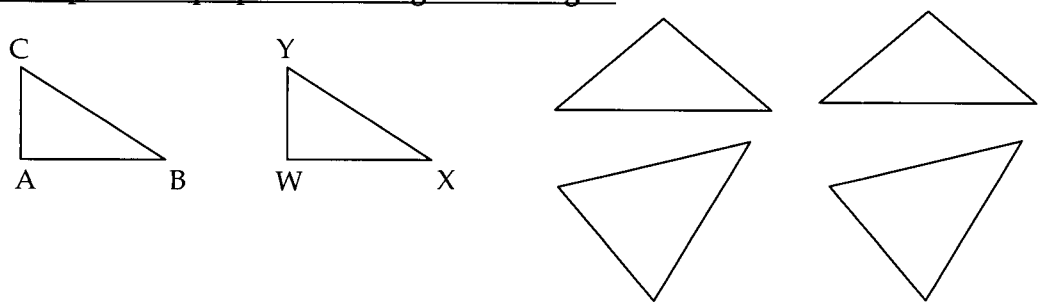
These are a special case of congruent plane figures. Develop with the students some of the reasons why these are special e.g. most congruent plane figures can be constructed from triangles, etc. Before developing with the students, the properties of congruent triangles such as corresponding angles and corresponding sides, explore the natural occurrence of triangles.

Ethnomathematical Dimension

Where do triangles occur in real life?

Get students to suggest reasons why these structures are built with triangular frameworks e.g.

Development of properties of congruent triangles



Match-up the corresponding sides and corresponding angles and use these to state the conditions for congruency in triangles. i.e. corresponding sides are equal, corresponding angles are equal.

Note: Emphasize that when referring to congruent triangles, we name their corresponding vertices in the same order. e.g. $\triangle ABC \cong \triangle WXY$

Exercise:

Suppose you know that $\triangle FIN \cong \triangle WEB$.

1. Name the three pairs of corresponding vertices.
2. Name the three pairs of corresponding sides.
3. Name the three pairs of corresponding angles.
4. Is it correct to say $\triangle NIF \cong \triangle BEW$?
5. Is it correct to say $\triangle INF \cong \triangle EWB$?

Homework:

1. Ask students to bring two pairs of congruent figures in the next class.
2. The following two triangles shown are congruent. Complete

   a) $\triangle ABO \cong$ ___ b) $\angle A \cong$ ___ c) $\overline{AO} \cong$ ___ d) $BO \cong$ ___

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Form: Two
Lesson #:
Duration: 45 – 50 Minutes

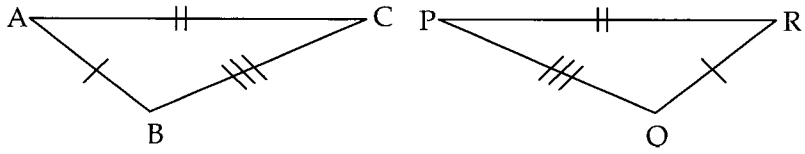
GEOMETRY

Congruent Triangles

Introduction and Review:
Review the notion of congruency in plane figures and review the homework exercise.

Development:
Some Ways to Prove Triangles Congruent
If we know that two triangles are congruent, we can conclude that the six parts of one triangle (sides and angles) are congruent to the six parts of the other triangle. Sometimes we may not need to compare all six pairs of parts to determine if two triangles are congruent. The following may be used:

Side-Side-Side (SSS) Postulate
If three sides of one triangle are congruent to three sides of another triangle, then the triangles are congruent.

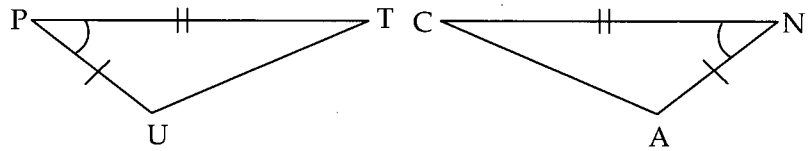


$AB \cong RQ, \quad BC \cong QP, \quad AC \cong RP$

$\therefore \triangle ABC \cong \triangle RQP$

Side-Angle-Side (SAS) Postulate

If two sides and the included angle of one triangle are congruent to two sides and the include angle of another triangle, then the triangles are congruent.



$PU \cong NA, \quad PT \cong NC, \quad \angle P \cong \angle N$

$\therefore \triangle PUT \cong \triangle NCA$

Angle-Sides-Angle (ASA) Postulate

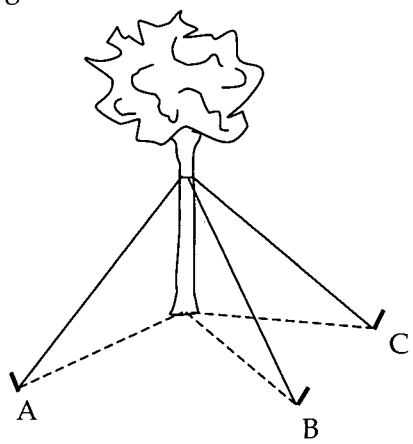
If two angles and the included side of one triangle are congruent to two angles and the included side of another triangle, then the triangles are congruent.

Ethnomathematical Dimension

- What is unique about congruent triangles?
- Explore with the students the occurrences of congruent triangles in real life.
- Explore with the students, uses of congruent triangles in life.
- How are congruent triangles created, say on embroidery, crafts, weaving, and construction?
- Do you think those who create those congruent triangles have the knowledge of the properties of congruent triangles?

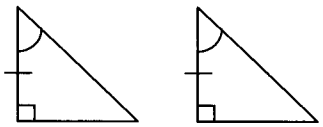
Exercise:

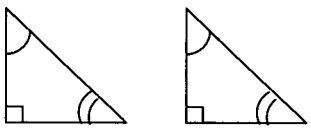
A young tree on level ground is supported at P by three wires of equal length. The wires are staked to the ground at points A, B, and C, which are equally distant from the base of the tree, T. Explain in a paragraph how you can prove that the angles the wire make with the ground are all congruent.

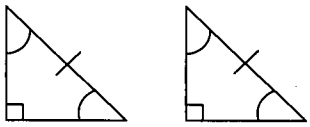


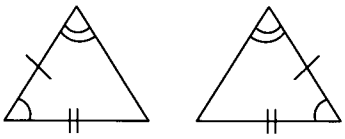
Homework

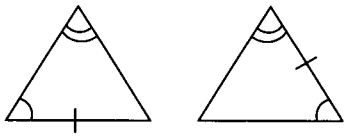
State which of the following must be congruent triangles and which need not be congruent triangles. In addition, give your reasons why you think the triangles are congruent. E.g. SSS or SAS or ASA.

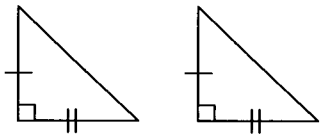
1. 

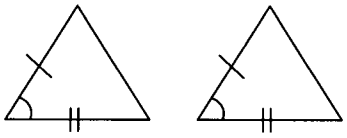
2. 

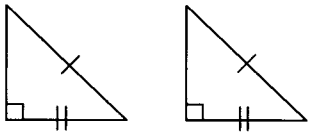
3. 

4. 

5. 

6. 

7. 

8. 

Ethnomathematical Approach

The goal of an Ethnomathematical approach is to identify the sociocultural elements that teachers and curriculum developers should consider along with students' interest and motivation when planning instruction. Such a curriculum will help to raise the awareness in the students of the occurrence of mathematics in their surroundings and their daily lives. It is also the aim of ethnomathematics to get students to realize that mathematics is the contribution of cultures from time immemorial. To achieve this, the students must *participate* in identifying mathematical concepts around them, especially outside the mathematics classroom.

Role of the Teacher

In an Ethnomathematical approach to the teaching of mathematics, the duties of the teacher include but are not limited to the following:

- facilitating learning;
- making the connections between mathematical concepts in the classroom and their occurrence in everyday activities;
- raising the awareness of the students vis-à-vis the occurrence of mathematics in their cultural practices;
- using history of the development of mathematical thought to et students to understand and realize that all cultures mathematize, although not exactly in the same way;
- setting up activities for students to explore the development of various mathematical concepts and ideas;
- raising the students' interest and self-esteem toward mathematics;
- developing in the students, a sense of ownership of mathematics i.e. that mathematics is not a western invention but mankind's attempt to adapt to its environment;
- developing mathematical concepts through historical pathways such as the growth of mathematical thinking in various cultures;
- raising the self-concept of the students and letting them believe that they can contribute to the growing knowledge of mathematics; and
- getting students to learn mathematics for its own sake, for its beauty and not necessarily for its utilitarian aspects.

Ethnomathematical Infusion

By grounding knowledge in the local tradition and adapting, interpreting and creating classroom activities that retain vital connections with the culture, the context, and the indigenous language, ethnomathematics can serve as a bridge between a local indigenous culture and the larger society. The teacher should therefore be familiar with the occurrence of certain mathematical concepts within the students' surroundings. It is advisable for the teacher to explore these occurrences first in the students' cultures and then in other cultures, as this will help the students in understanding that mathematical ideas exist in every culture and are not the exclusive development of western societies.

Form: Two
Lesson #:
Duration: 45 – 50 Minutes

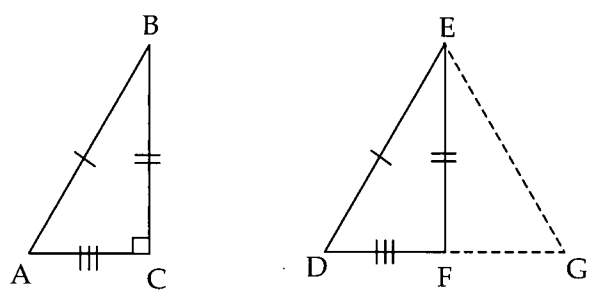
GEOMETRY

More on Congruent Triangles

Introduction and Review:
Review homework exercise on congruency postulates.
Review the three postulates i.e. SSS, SAS, and ASA.

Development:

Right-angled – Hypotenuse – Side (RHS) Postulate
In right-angled triangles, if the hypotenuses are equal in length and one other side in each triangle are also equal in length, then the triangles are congruent.



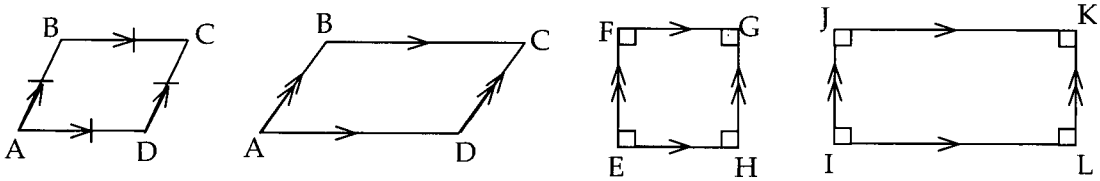
$$\angle C = \angle F = 90^\circ$$
$$\overline{AB} = \overline{DE}$$
$$\overline{BC} = \overline{EF}$$
$$\Rightarrow \quad \overline{AC} = \overline{DF}$$
$$\therefore \triangle ABC \cong \triangle DEF$$

Summary of Ways to Prove Two Triangles Congruent
All Triangles : SSS, SAS, ASA.
Right-angled Triangles : RHS

Applications of Congruent Triangles

Properties of Parallelograms

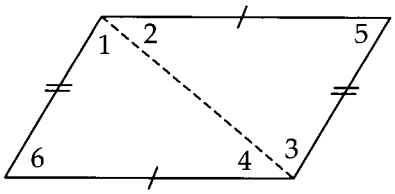
A parallelogram is a quadrilateral with both pairs of opposite sides parallel.



- Opposite sides of a parallelogram are equal.
- Opposite angles of a parallelogram are equal.
- Diagonals of a parallelogram bisect each other.

Since rectangles, rhombuses and squares are parallelograms, they have all the properties of parallelograms. They also have the following properties:

- Diagonals of a rhombus bisect at 90°.
- Diagonals of a rectangle are equal.



$\angle 1$ & $\angle 3$ are alternate interior angles & are equal.

$\angle 2$ & $\angle 4$ are alternate interior angles & are equal.

$\angle 5$ & $\angle 6$ are opposite angles & are equal.

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Form: Two
Lesson #:
Duration: 45 – 50 Minutes

GEOMETRY

Similar Triangles

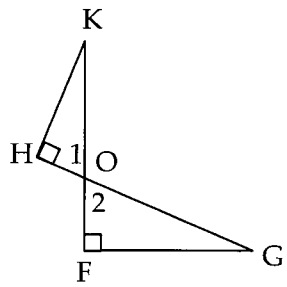
Introduction and Review

Review of the exercise on string figures and the instructions generated by the students to construct the various diamond systems. Also review the congruent triangle postulates.

Development

Two polygons are similar if their vertices can be paired so that:
1. Corresponding angles are congruent.
2. Corresponding sides are in proportion. (Their lengths have the same ratio.)

Angle-Angle (AA) Similarity Postulate
If two angles of one triangle are congruent to two angles of another triangle, then the triangles are similar.



Given: $\angle H$ *and* $\angle F$ *are right – angles.*
Prove: $HK.GO = FG.KO$

Side-Angle-Side (SSS) Postulate
If an angle of one triangle is congruent to an angle of another triangle and the sides including those angles are in proportion, then the triangles are similar.

Side-Side-Side (SSS) Postulate
If the sides of two triangles are in proportion, then the two triangles are similar.

Ethnomathematical Dimension

The Woven Heart Project
Students are asked to create a heart-shape using only two geometric objects such as a circle and a square.

- This project will help students incorporate other curriculum areas into mathematics.
- Expose students to the role of women and minorities in the field of mathematics.
- Demonstrate practical uses of mathematics.
- Reward creativity.
- Encourage cooperative learning.

Students will eventually discover that they can create a heart shape by using two semi-circular shapes and a square. See below.