

UNIVERSITY OF CAPE COAST

STUDENTS' ACHIEVEMENT IN MATHEMATICS IN THE LIBERIA  
SENIOR HIGH SCHOOL CERTIFICATE EXAMINATION (LSHSCE)  
AND HOW IT IS INFLUENCED BY TEACHER CHARACTERISTICS

BY

JOSEPH FLEKPEDOLO YOUNN

2009

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Thesis Submitted to the Department of Science and Mathematics Education  
of the Faculty of Education, University of Cape Coast in Partial Fulfilment of  
the Requirements for the Award of the Master of Philosophy Degree in  
Mathematics Education

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## DECLARATION

### Candidate's Declaration

*I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere.*

Candidate's Signature:.....Date:.....

Name: Joseph Flekpedolo Younn

### Supervisors' Declaration

*We hereby declare that the preparation and presentation of this thesis were supervised in accordance with guidelines on supervision of thesis laid down by the University of Cape Coast.*

Supervisor's Signature:.....Date:.....

Name: Dr. Jonathan A. Fletcher

Co-Supervisor's Signature:.....Date:.....

Name: Mr. Benjamin Yao Sokpe

## **ABSTRACT**

The purpose of the study was to describe twelfth grade students' perception of the mathematics teachers' teaching style, to describe the mathematics teachers' perception of in-service education and training (INSET) programmes, and to investigate twelfth grade students' achievement in Liberia Senior High School Certificate Examination (LSHSCE) mathematics and how it is influenced by teacher characteristics. The study took place in fourteen purposively selected senior high schools in Nimba County, Liberia.

The study involved 280 twelfth grade students and ten teachers teaching mathematics. Twenty students were randomly selected from each school. The study used questionnaires and data sheet to collect data. The data were analysed by means of frequency distribution, simple percentages, One Way Analysis of Variance (ANOVA), the Duncan multiple-range test of the Statistical Package for Social Sciences (SPSS). Excel gave graph for the past twelfth grade students' LSHSCE mathematics scores.

The results showed that the students viewed the mathematics teachers' teaching style as a combination of teacher-centred and student-centred teaching styles, the relevant authorities of Nimba County School System kept low profile on the provision of INSET programmes for the mathematics teachers, the number of trained and qualified high school mathematics teachers was inadequate, and the mathematics teachers' characteristics positively influenced the students' achievement in LSHSCE mathematics.

Based on the findings, a number of recommendations (e.g. provision of scholarships for high school graduates to train and qualify as mathematics teachers) for improving on teaching and learning of mathematics were made.

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## **DEDICATION**

To my mother, Luckie Glaydor, my late grand mother, Kou Flekpe and my late grand father, Kolawolo Younn.

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## **LIST OF ABBREVIATIONS**

CEO	Chief Education Officer
DEO	District Education Officer
DMRT	Duncan Multiple Range Test
LRCS	Liberia Red Cross School
LSHSCE	Liberia Senior High School Certificate Examination
MOE	Ministry of Education
NAEP	National Assessment Education Progress
NBPTS	National Board of Professional Teaching Standards
NRC	National Research Council
TLA	Teaching-Learning Aids
UNDP	United Nations Development Programme
UNESCO	United Nations Education Scientific and Cultural Organisation
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WAEC	West African Examinations Council
YMCA	Young Men Christian Association

## **CHAPTER ONE**

### **INTRODUCTION**

#### **Background of the Study**

Castle (1971) states that the mind of the man or woman who goes on learning stays alive; the mind of the person who thinks he or she knows all he or she needs to know is already dead. This statement implies that the teacher will remain a learner all his or her life. The minds of teachers stay active when they attend pre-service (if they are not already trained) and/or in-service teacher training. The teacher earning the Teaching Certificate is just at the beginning of the academic and professional training and journey.

The quality of learning in any system of education of any nation will always be determined by the knowledge of the teachers who are key providers of education within the system. Hence the teacher must always know more than it is necessary for the students to know. Teachers ought to strive to enrich their minds with new knowledge and ideas so that their teaching can become more exciting and attractive. The training of mathematics teachers will help to strengthen them with the requisite mathematical knowledge, skills and ideas to enable them facilitate the learning of their students.

Mathematics is indeed one of the most useful and fascinating subjects humans have created. The importance of mathematics in everyday life cannot be overstated. It borders on a variety of areas, but basically concerns itself with numbers and quantity, forms and relationships. Nearly every part of

human life involves mathematics. It is an essential part of every scientific study. It is an integral part of engineering, industry, physical and social sciences, business, and health. It is thus believed to be a key to opportunities.

Every student must study mathematics during the educational process for his or her personal development and achievement in today's technologically and progressing world. Mathematics has been a prerequisite requirement of access to education worldwide. A good performance in mathematics is one of the basic requirements for further academic and professional advancement in many areas. For example, a candidate must pass the Liberia Senior High School Certificate Examination in mathematics administered by West African Examinations Council (WAEC) in order to earn a high school certificate. Candidate seeking admission to university may have to pass a mathematics entrance test set by the university. Mathematics plays a critical filter and gate keeping role in many institutions of learning. The training of mathematics teachers will keep on facilitating students' learning of mathematics as well as physical sciences.

The training of teachers started in Liberia nearly a century ago. According to Reeves (1995) the first real efforts toward teacher education in Liberia began with Julius C. Steven. Steven introduced two-week teacher institutes when he became general superintendent of education in 1900. At all these institutes, teachers received in-service training. In 1952 the two-week institutes, running alongside new teacher training institutions, were extended to four weeks and were known as vacation schools (Sherman, 1982). Attendance at vacation schools was compulsory. Teachers were taught content as well as methodology.

The vacation schools were conducted during the vacation period, a time which teachers regarded as a rest period. Teachers had to pay their own transportation and maintain themselves in the city in which the school was held. Attendance at the vacation did not affect salary. The vacation school idea was abandoned and teachers were encouraged to attend evening classes to improve their own education. This was called the extension school. Regular attendance made teacher earn a grade each year (Reeves, 1995).

Teacher training institutions began to emerge in Liberia in the late 1940's. Teacher education in these institutions was (and still is) a special education programme organised to provide academic and professional training to individuals who would become professional teachers at elementary, junior, and senior high schools, and higher institutions of learning (Reeves, 1995).

There are currently two universities in Liberia that grant Bachelor of Science (B.Sc.) Degrees in Education. They are the University of Liberia (public) and Cuttington University (private). These two institutions of higher education run four-year programmes for the training of teachers. Cuttington University began training teachers at the Bachelor's level in 1947; the William V. S. Tubman Teachers College of the University of Liberia started training teachers in 1949.

Schools were not many at the time and they were basically concentrated in the big cities along the coast. These two universities could cope with the challenges of producing teachers for these few schools. But as schools extended and expanded in the rural areas, the need for more teachers in these areas became greater. A new kind of non-university teacher training



institutions became established. They were known as rural teacher training institutions. There are three of such teacher training institutions in Liberia presently. These are Kakata Rural Teacher Training Institute (KRTTI) in Margibi County was established in 1964; Zorzor Rural Teacher Training Institute in Lofa County was founded in 1962; and Webbo Teacher Training Institute was founded in 1962 and became operational in 1999.

All of these teacher training institutions are established to train teachers in methodology and content subject areas such as mathematics, science, language arts, and social studies. Training at these institutions proceeded well, and graduates from them were assigned to both public and private elementary, junior, and senior high schools in the country. The training of teachers and all educational activities in Liberia were disrupted and paralysed due to the fifteen-year civil strife that started in the country on December 24, 1989.

Arnhold, Bekker, Kersh, McLeish, and Phillips (1998) assert that the provision of adequately trained teachers in post conflict situations is important because they contribute significantly to the long-term development of the education system. The necessary and appropriate professional teacher knowledge and skills are needed to empower the teacher to enable him or her meet the challenges of facilitating student learning of mathematics and other core subjects. Through the guidance of the trained and capable mathematics teachers, students are able to learn through their misconceptions.

Mathematics is viewed as a difficult discipline and students often fail to grasp the concepts if they are not taught by a trained and experienced teacher who will help facilitate teaching-learning using appropriate teaching

methods and manipulative materials. Mathematics Education theory (for example, Piaget's cognitive theory of seriating and transitivity and Diennes's theory of mathematics learning) describes numerous body of abstract knowledge that has a large number of applications in the teaching and learning of mathematics. Mathematics teachers will become au courant with such teaching-learning theories when they go through a formal teacher training.

Formal teacher training, teacher workshops and seminars will expose teachers to practical knowledge of the teaching-learning theory generally as well as subject specific teaching-learning theory. Teachers with an appropriate knowledge of such theory will be able to challenge and enhance students' learning and understanding of mathematics through the use of necessary teaching materials. Engaging students through the use of manipulative mathematics materials, for example, helps to foster their understanding and enhance their achievement in the subject. Indeed, Post (1992) points out that effective learning of mathematics often involves the use of manipulative materials and the opportunity to interact with other students. Manipulative materials assist students in conceptualising abstract phenomena.

Bruner (as cited in Post, 1992) states that manipulative aids help learners move from concrete situations and problems to abstract ideas. Manipulative instructional items enhance students' imagination of abstract ideas. Students may do rote memorisation, for instance of some theorems in geometry, if they are not challenged and opportuned to use manipulative aids. Consider the theorem, "The exterior angle of a triangle equals the sum of the two remote interior angles." Having the students to use manipulative aid (in this case a protractor) to measure an exterior angle of the triangle and then

compare its size with the size of the sum of the two far away interior angles of the triangle would help the student to understand and apply the theorem. However merely quoting and solving problems regarding this theorem may get students to do rote memorisation.

Training of mathematics teachers promote their effectiveness in content area, teaching methods, knowledge about their students, lesson planning, and making connections between and within subjects. For example, an experienced, trained, and knowledgeable teacher will make appropriate connections between mathematics and geography in map reading, mathematics and chemistry in the use of ratio and proportion; algebra and geometry in calculating measures of angles about a point, and so forth. Training empowers the teacher to integrate mathematics and other subject areas. Hence training prepares teachers for good teaching and good students' achievement results.

Porter and Brophy cited in Ellis (1992) summarise these points about good and knowledgeable teachers in their pursuit to help their students achieve well in any discipline including mathematics:

1. Good teachers know very well the content they teach.
2. Good teachers know and can use wide range of instructional strategies.
3. Good teachers make expert use of existing instructional materials.
4. Good teachers are thoughtful and reflective about their practice.
5. Good teachers are clear about their instructional goals.
6. Good teachers know their students.
7. Good teachers communicate to their students what is expected of them and why.

8. Good teachers accept responsibility for their student outcomes.
9. Good teachers attempt to make connections.
10. Good teachers monitor students' progress and provide appropriate feedback.

To ensure quality teaching and learning in institutions in Liberia, the Government of Liberia, through the Ministry of Education (MOE, 2000) developed the following six objectives:

1. Renovation, reconstruction and strengthening of rural teacher training institutions and instituting a full-time regular programme for in-service and pre-service teachers.
2. Allocation of adequate funds for teacher education, development and welfare.
3. Train more teachers by strengthening all rural teacher training institutions and degree granting colleges and institute a full-time regular programme for in-service and pre-service teachers.
4. Improvement and enhancement of high standards in the school system by making sure only those teachers who have obtained the minimum of "Grade C Teacher Certificate" will be employed to teach in the Liberian school system. The grace period of five years (2001-2005) is set for teachers who fall below this standard to qualify themselves.
5. Establishment of National Board for licensing teachers and ensuring that all teachers in the school system are licenced.
6. Revision of conditions for service as well as increase the salary of teachers through established system of reward based on merit comprehensive salary structure, tenure and qualifications.

Efforts by Government to enhance and promote mathematics education in the country made substantial headway in the 1980s. These education initiatives got sponsorships from friendly and empathetic nations like the United States of America, India, China, Japan, Canada and so forth. These programmes were implemented through the Ministry of Education.

The programmes were disrupted by the civil strife which started on December 24, 1989 and lasted for fifteen consecutive years. The war affected all sectors of Liberia. The civil crisis brought education in the country to a complete state of paralysis. School buildings were being looted, destroyed or used to accommodate displaced people or host military units. Some teachers became victimised by losing their lives either through the barrel of the gun or naturally due to ailing health conditions or hardships caused by the war.

Education then, was no longer of much significance. As a result, many teachers (including mathematics teachers) were forced to flee the country and abandoned the teaching profession for other professions considered to be lucrative. All teacher training institutions in the country were closed; thus no new breeds of teachers were being trained to fill in the gaps.

Notwithstanding these challenges there is now a new and positive dimension to the Liberian situation. Under the watchful eyes, sponsorship and supervision of the United Nations, general and presidential elections were democratically held in 2005 after the crisis ended. With the assistance of some friendly nations and international organisations like UNICEF and UNDP, the Government of Liberia has actually started implementing the Ministry of Education (MOE, 2000) Sector Master Plan: 2000-2010. Among other things, the implementation is concentrated on the following:

1. Strengthening the Teachers Colleges by providing adequate facilities and relevant programme as well as support for qualified teacher trainers, training and staff development incentives/opportunities in the Teachers Colleges and Universities;
2. Attracting highly qualified teachers and instructors by providing attractive salaries, incentives and benefits;
3. Supporting WAEC to effectively provide sufficient and reliable evaluation of secondary school programmes;
4. Providing subsidies; loans and scholarship schemes to support deserving students;
5. Rehabilitate, reconstruct and strengthen the Senior High Schools and Multilateral High Schools performances, facilities/personnel and equipment to make them functional.
6. Reviewing, improving and rationalising the employment policy, salaries and conditions of service of high school teachers.

### **Statement of the Problem**

The Government of Liberia and other supporting agencies have made tremendous contributions to Mathematics Education in the country. Nimba County which is the major focus of this study immensely benefited from these initiatives. Both public and private schools in the county were provided with qualified mathematics teachers. The education initiatives of some private schools for example, were subsidised by National Government with the assignment of qualified mathematics teachers to the schools. Public academic institutions such as Sanniquellie Central High School, John Wesley Pearson

High School, Tappah Memorial High School and many other schools were staffed with qualified mathematics teachers.

Experienced and qualified Peace Corps Volunteers were sent from the United States of America to work alongside Liberian mathematics teachers as counterparts. Some of these Liberian mathematics teachers subsequently got scholarships to study at the Master's Degree level in the United States of America and in Great Britain. These scholarships came as a result of bilateral agreements between the Government of Liberia and USAID. USAID also assisted in training some teachers including mathematics teachers from the Rural Teachers Training Institutes in the United States of America, Great Britain and Nigeria.

However the entire education system in Liberia collapsed as a result of the civil conflict. The civil crisis has ended now, and normality has once again returned to Liberia. Teacher Training Institutions have reopened and resumed with reinvigorated spirits of training teachers. Teachers (of mathematics, science, and other major subjects) have been trained, graduated and assigned to teach in Elementary, Junior and Senior High Schools in the county.

High schools in the country have also been reopened and are now carrying on full-time academic activities. However, the Local Office of WAEC has made numerous reports about poor performance of high school students in the Liberia Senior High School Certificate Examination (LSHSCE) mathematics since the end of the civil conflict. For example, WAEC (2006) reported that the performance of twelfth grade students in LSHSCE mathematics was far below average. There have been major public reactions to WAEC's reports concerning the low achievement of twelfth grade students on

the examinations. There abound anecdotes to suggest that teachers of these students are untrained, unprepared and unqualified. Some commentators have even claimed that many of the teachers and the students are about at the same grade level.

Mathematics is a core subject and like the counterpart high schools in Sierra Leone, Ghana, Nigeria, and the Gambia, all twelfth grade students in these schools in Liberia also write a similar examination in mathematics administered by WAEC. This makes the WAEC observations worth taking seriously.

Indeed the goal of improved education is far too important to be left to the idiosyncratic judgments of individual teachers. Government has increasingly explicit expectations about what students should know and be able to do, and they rely on standardised assessment (mainly WAEC) to measure whether students have achieved these goals (Tatto & Plank, 2007). WAEC is an institution in Liberia which determines (by assessing students academic progress) how well or badly Government's education goals are being met. Therefore, their view about students' mathematics achievement in Liberia is a cause for concern.

As indicated earlier, Teacher Training Colleges and Universities have been reopened and are operating and new high school Mathematics teachers are being recruited, trained and assigned to teach mathematics in the country. Other trained teachers are being re-trained at teachers' workshops and seminars.

If teacher training institutions in Liberia are now operating full-scale, and if high school mathematics teachers are being trained and assigned to



teach mathematics in high schools in the country, and if those previously trained high school mathematics teachers who are presently teaching in the high schools are also being re-trained, then there is a need to investigate how well high school students are doing in the Liberia Senior High School Certificate Examination mathematics in Nimba County. The lack of current information regarding the students' achievement in mathematics and how it is influenced by teacher characteristics after the war is a problem which requires a solution. This study is a small step towards finding solution to this problem.

Indeed, if teacher training institutions in Liberia are now operating full-scale, preparing teachers (including teachers of high school mathematics), and if those mathematics teachers who have been prepared through teacher training, teachers' seminars and teachers' workshops are being assigned to teach mathematics in high schools in Nimba County, then the impact of some of the teachers' characteristics (i.e. training status, area of specialisation, type of academic qualification, and years of teaching experience) on the students' achievement can be determined by exploring their relationship with twelfth grade students' recent achievement in Liberia Senior High School Certificate Examination (LSHSCE) mathematics. The current achievement of twelfth grade students in LSHSCE mathematics would help to make inferences about the effect of the teachers' characteristics on students' performance in mathematics in the selected schools in Nimba County, where the study was conducted.

## **Purpose of Study**

This study intended to access and to describe mathematics teacher characteristics and how it influences Twelfth Gradestudents' achievement in LSHSCE mathematics in Nimba County. The study was specifically focused on the following two major variables:

- high school students' LSHSCE mathematics achievement
- teachers' characteristics, such as training status, area of specialisation, type of academic qualification, and years of teaching experience

The aim of the study was to describe students' perception of their teachers' teaching style; teachers' perception of in-service education and training (INSET); the trends of high school students' LSHSCE mathematics achievement in the last four years (2004/05-2007/08); and investigate the influence of mathematics teachers' characteristics on high school students' achievement in the subject.

## **Research Questions and Hypotheses**

To achieve the above aim, the following research questions and hypotheses were formulated to guide the research process:

1. Do high school students perceive the teaching style of their mathematics teachers as teacher-centred, student-centred, or both?
2. How do the mathematics teachers perceive the provision of INSET in Nimba County in post war era?
3. How well are high school students performing in mathematics in the LSHSCE?
4. What is the influence of high mathematics teachers' characteristics (i.e. training status, area of specialisation, type of academic qualification, and

years of teaching experience) on their students' achievement in LSHSCE mathematics?

The first three research questions were answered by means of the following analyses:

Research Question One was addressed by analysing students' responses in the students' questionnaire. Similarly, Research Question Two was addressed by analyzing teachers' responses in the teachers' questionnaire. Research Question Three, on the other hand, was addressed by analyzing the trend in the performance of the twelfth grade students in the Liberia Senior High School Certificate Examination (LSHSCE) mathematics in the four academic years (2004/05-2007/08).

In order to answer the fourth research question above, the following null hypotheses were formulated to guide the study:

1. A high school mathematics teacher training status has no influence on his or her students' achievement in LSHSCE mathematics.
2. A high school mathematics teacher specialisation in the subject has no influence his or her students' LSHSCE mathematics achievement.
3. A high school mathematics teacher qualification in the subject does not influence his or students' LSHSCE mathematics achievement.
4. A high school mathematics teacher experience in teaching the subject has no effect on his or her students' LSHSCE mathematics achievement.

### **Significance of the Study**

The study would help education planners, county education officers, district education officers, school administrators, etc in the recruitment and placement of mathematics teachers in schools in the Nimba County School

System. The study would also help to explain the current trend in the achievement of high school students in the Liberia Senior High School Certificate Examination (LSHSCE) mathematics in Nimba County. The study would also help to explain to the relevant authorities of the Nimba County School System, the mathematics teachers, students, parents, and guardians the implications for such trend in students' achievement in mathematics. It would again help to reinforce the professional and ethical responsibility of the teachers. Finally, the study could create the awareness of teacher characteristics variables that are important in the preparation of mathematics teachers.

### **Delimitations**

The research was limited to Nimba County. Nimba County is located in the north central geographical region of Liberia. At the moment there are twelve educational districts in Nimba County. Eight of these school districts have complete senior high schools. A complete senior high school has twelfth grade as its terminal class. The other four educational districts do not have complete senior high schools. Instead, they have semi-senior high schools. These semi-senior high schools have either tenth grade or eleventh grade as the highest class at the moment.

Nimba County has thirty-one senior high schools spread throughout the eight districts. The study was carried out in five educational districts. These five school districts have a total of twenty-five complete senior high schools. The research covered fourteen of these schools. Of these fourteen senior high schools, eleven are semi-urban. The other three senior high schools are located in rural settings.

Based on ownership the selected high schools in these educational districts in Nimba County are categorised into three groups as follow:

1. Public/government schools. There is one public senior high school in each of the five districts where the study was carried out.
2. Private individual senior high schools. These are schools that are built and run by their proprietors or by authorities designated by the owners of the institutions. Other private schools are owned by non-individual entities like LRCS and YMCA.
3. Parochial schools. These are schools owned and operated by churches or religious organisations.

The study particularly looked at the high school students' perception of the mathematics teachers' style of teaching the subject; the high school mathematics teachers' perception of the provision of in-service education and training (INSET) in Nimba County; the current trends in the achievement of high school students in LSHSCE mathematics in Nimba County; and the influence of the mathematics teachers' characteristics and senior high school students' achievement in Liberia Senior High School Certificate Examination (LSHSCE) mathematics in Nimba County. A four-year time frame (2004/05-2007/08) inclusive was considered for the study. The characteristics of senior high school teachers may have influence on students' achievement in other subjects like economics, English, chemistry, to name a few. However the study was focused on high school mathematics.

The researcher purposively limited the conduct of the study to Nimba County for several reasons including the following:

1. The researcher is familiar with the county.

2. The time was very short to cover the entire country or to include other counties in Liberia in the study.
3. Nimba County, like other counties in Liberia, suffered the loss of teachers, including well-prepared mathematics teachers during the Liberia upheaval.
4. It is expected to have similar characteristics like those of other counties of Liberia having common borders with her.

### **Limitations**

A major limitation of the study was that the twelfth grade students whose LSHSCE mathematics assessment results were used were no longer attending these high schools. Those students had completed their studies at the high schools. However, the present twelfth grade mathematics teacher in each of the high schools also taught those students whose LSHSCE mathematics results were used for the study. Nevertheless, these teachers may have improved on their teaching styles, gained further qualifications, or gained more experience, since last year. Thus, any relationship between any of the teacher variables and achievement should be interpreted with great care.

Therefore, the LSHSCE mathematics results for the past twelfth grade students are only being used to make inferences about the teacher characteristics as they were in the previous years.

Another limitation was that the difference in long vacation periods for the public and private schools (after the Christmas and New Year holidays) impeded the research work. The changes in vacation schedules were abrupt. These changes came about after the researcher, the principals, and the mathematics teachers had concluded on schedules for the researcher to return to the school to collect data. The private and public schools did not resume

classes at the same time after the holidays. When the private schools were in session, the public schools were on mid-year vacation. In a like manner when the public schools were in session the private schools were closed. This means that the time for visits and for data collection at the high schools were limited. It would have been ideal to collect the data around the same time. This would have given the researcher ample time to make more visits to the schools. All these barriers could influence the accuracy of the data. More visits to schools could have yielded more data which would have helped the researcher to explain the findings better. In spite of the above limitations, efforts were made by the researcher to ensure that the data was collected in the same manner in all the schools involved in the study.

#### **Definition of Terms**

**Highly trained** - having the requisite subject matter knowledge and teaching skills.

**Idiosyncratic judgments** - decisions made by an individual without an input from any other person.

**Less trained** - not having the required subject matter knowledge and teaching skills.

**Qualified teacher** - a teacher who has the requisite subject matter knowledge but no formal teacher training experience.

**Rural** - more than forty miles away from the national capital and not having health facility like hospital or referral clinic.

**Semi-urban** - more than forty miles away from the national capital and having a health facility such as a hospital or a referral clinic and accessible by motor road.

**Trained** - having learned the principles, psychology and skills of teaching and learning and being able to apply them and certified to teach.

**Untrained** - not having formal training experience from a teacher training institute and therefore not certificated to teach.



## **CHAPTER TWO**

### **REVIEW OF RELATED LITERATURE**

This chapter reviews related literature in support of the goals of the study. The review is organised under the following headings:

1. High school students' achievement in mathematics.
2. In-service education and training (INSET) for mathematics teachers.
3. Teachers' characteristics and its influence on students' achievement.

#### **High School Students' Achievement in Mathematics**

The concept of achievement has been viewed by people in different ways. According to Hammil (1987) achievement is the skill a person has mastered as a result of direct instruction. The skills, according to Hammil (1987) may be teacher-taught, parent-taught, or self-taught, but they exist in individuals who have had specific training. He further declared that skills like reading, writing, computer-use, alphabetical knowledge or typing are not innate rather they are learnt before they are achieved. He concluded that achievement tests in schools are administered to find out how much a student knows about a particular content or subject taught and can be attained as a result of instruction.

Sprinthall and Sprinthall (1990) also said that achievement is an assessment of what a person has done and is capable of doing. They confirmed that achievement is the abilities and capabilities of the learners which are the

determinants of their performances. They mentioned that “abilities” characterise the things one is supposed to be able to learn or absorb. On the other hand, they said “capabilities” characterise the things individuals can do at each level of the program of studies. Based on these definitions it can be inferred that achievement in mathematics can be determined by the scores a student gets when he or she is tested on the mathematics he or she has been taught.

According to Klein (2000) student engagement in mathematics plays an important role in student success in mathematics. Student engagement in mathematics refers to students’ motivation to learn mathematics, their confidence to succeed in mathematics, and their emotional feelings about mathematics. Students who are motivated to learn mathematics will tend to learn more and be receptive to further learning. Klein (2000) confirms that there are many obstacles which mitigate students’ achievement in mathematics. Accordingly poverty is considered the worst of these barriers to students’ achievement in mathematics. For example, in the eighty school districts within the boundary of Los Angeles County there were tens of thousands of public school children who were homeless. For such children the concept of homework is frustrating and limited resources of the school cannot compensate the heart wrenching effects of their daily plights (Klein, 2000). Still there are many other students who are not homeless, however their sources of support are meagre. Amidst these difficulties which tended to hinder the achievement of students in mathematics in the school districts, Klein (2000) suggests three key strategies to students as possible remedies: a clear set of high quality grade by grade standards; textbooks and curricula for

teachers and students that are aligned to the standards; and teachers' knowledge of mathematics to teach to the standards. Hence, mathematics achievement according to Klein (2000) can be enhanced through appropriate steps.

Other research has linked students' academic achievement and the pursuit to learn with the opportunity for economic success. For example, Ford (1992a), Mickelson (1990), and Murdock (1999) have found that if students see a relationship between success at school and economic success, they are more likely to work hard and be more successful. Murdock (1999) has found that the level of expectations teachers have of the students may affect the students' achievement. Where teachers held high expectations of students, they were engaged more academically. If, on the other hand, teachers have low expectations of students' achievement students achieve little. Child (2004: 197) also observed that the need for individuals to achieve can be encouraged by creating learning environment in which "the need for achievement in academic studies is raised." Capel, Leask, and Turner (2005) argue that each individual sets themselves a standard of achievement, according to their level of aspiration. Therefore, they declare, it is important to raise students' levels of aspiration. They observe that students who are challenged are more likely to improve their performance than those who are not challenged. Based on these findings, it is necessary that teachers engage students in meaningful and more challenging activities.

Wentzel (1997) observes that students are motivated by teachers who know, support, challenge, and encourage them to act independently from each other and from the teacher. According to Manouchehri (2004) an autonomy-

support environment is one in which teacher gives increasing responsibility to students, e.g. choices or options about what they want to do; encourages students' decision-making by spending less time talking, more time listening, making less directive comments, asking more questions, and not giving students solutions; allow students to work in their own way; and offer more praise and verbal approval in class. Such an environment supports students' academic and social growth by increasing intrinsic and self-motivation to succeed at school. Based on Manouchehri (2004) findings it may be said that teachers should encourage and support students' academic independence in order to foster their (students') achievement in mathematics and all other subjects.

Darling-Hammond (2000) asserts that teacher quality variables appear to be more strongly related to students' achievement than class sizes, overall spending levels and teacher salaries. In the UK, under-achievement among some teenagers has been blamed on the accountability culture in the British school system. (Hargreaves, 2003; Sachs, 2003; Stronach, Corbin, McNamara, & Warne, 2002) claim that centrally determined targets are unlikely to raise standards and in fact may not help to sustain improvement. These authors also believe that the use of such targets is most likely to encourage traditional practices and suppress creativity.

This accountability culture seems to be different from the culture that existed in the 1980s. For example in the 1980s the Cockcroft Report (1982) commenting on whether there was a need for teaching methods to be detailed, acknowledged that the authors of the report were aware that there were teachers who wished them to indicate a definite style for the teaching of

mathematics, but they did not believe that was either desirable or possible. However, ten years ago, Brown (1999) highlighted the growing pedagogic control, suggesting that, the post-war era of teacher and pupil autonomy is apparently over, and the education system is to be driven by national targets and norms and regularly inspected like steel production in the Soviet state or rice production under Chairman Mao. (p.15).

Mereku (2000) in observing mathematics in Ghana from 1960 to 2000 commented on the influence the changes in mathematics curriculum had had on the performance of students. In his analysis, he cited a study commissioned by the Ministry of Education of Ghana in the early part of the decade. The study showed that mathematics teaching in basic schools focused on computational skills, learning of formulas, and rote practice of teaching as telling. The implication, according to him, was that by the time the majority of the pupils begin secondary education; their foundation in basic school mathematics was terribly low.

Research and evidence from practice (Mercer, 2000; Wegerif & Dawes, 2004) show that actively teaching students how to learn, how to explain themselves, how to ask probing questions, sharing the lesson objectives with them, and teaching them how objectives link with activities and assessment tasks leads to raise achievement. From the research and evidence from practice, it can be said that teachers' teaching style positively influences students' achievement.

Research has also shown that students' achievement in mathematics is linked with the encouragement and support given them in mathematics classes. The National Council of Teachers of Mathematics (NCTM) (as cited

in Appelbaum, 2008) observed that students who have opportunities, encouragement, and support for speaking, writing, reading, and listening in mathematics classes reap dual benefits: they communicate to learn mathematics, and they learn to communicate mathematically. The current researcher analyses this research finding to mean that teachers of mathematics should recognise mathematics as a group experience that requires reading, writing, listening, speaking, and the use of various modes of representation; and that teachers of mathematics should therefore focus on the building of classroom community in which students feel free to express ideas. In order for students to achieve in mathematics, teachers of such classroom community should not rush to formal mathematical language; instead they should build on the language and experience of the students. For example, the current researcher had an experience with a class of tenth grade students in an algebra lesson involving translating two-digit word problems into linear equations. At first many of the tenth grade students could not write an appropriate equation to represent a two-digit verbal problem. This happened because the students found it difficult to interpret and apply the words “interchange” and “reverse.” The teacher later observed some of the students who got the idea of translating the word problems into symbols helping their classmates sitting next to them using the expression “Taiwan” it. Building on the students’ language in interpreting the words “interchange” and “reverse”, the mathematics teacher wrote “Taiwan” followed by either “interchange” or “reverse” in a parenthesis and quickly adding “cress-cross”. The teacher later observed that many of the students could translate two-digit problems from words into equations.

This situation got the researcher to conclude that students' language may help to foster their achievement in mathematics.

### **The Stages of Teacher Training**

It is common to speak of the training of a teacher as occurring in three stages. Farrant (2004) names these stages of training teachers as pre-service, induction and in-service training.

The induction stage of training teachers has not been adopted or used in Nimba County or in any other part of Liberia. Induction is only being mentioned here as one of the three stages of training teachers. For this reason, induction is not discussed in this study. The other two stages of teacher training, pre-service and in-service are discussed in this study. However, both of these two stages are not equally discussed. Literatures related to the latter aspect of teacher training, that is in-service education and training (INSET), are discussed the more. This is so because INSET is one of the concerns on which the review is organised.

### **Pre-service Teacher Training**

Pre-service training is usually provided in a teacher's college where the student teacher is introduced to the knowledge and skills needed to do a professional job in teaching (Farrant, 2004). During pre-service training the student is introduced to the principles that underlie teaching such as the aims of education, the curriculum, the nature and characteristics of child development, methods of learning and teaching and teaching and learning resources.

The key role of a teacher is that he or she should be a facilitator of learning and an agent of change. It is therefore crucial that the teacher be well-

prepared in order to make him or her carry out the necessary roles effectively. Pre-service training may provide the mathematics teachers (and teachers of other core subjects) the competencies they need to make them perform the facilitator's role. According to Farrant (2004) pre-service training nearly always introduces the student teacher to the practical work of actual teaching in a school but it is no more than an initiation. This initial training the teacher trainee receives cannot fully prepare him or her to teach for life. This is so because the skills, knowledge and competencies he or she has acquired during the pre-service training are inadequate (Farrant, 2004).

There is an explosion of knowledge taking place in the world each day. Besides this explosion of knowledge, the skills and knowledge the teacher has gained from an initial training may start to diminish with time. This is especially so when he or she is isolated from reading materials or libraries to keep him or her informed about latest developments in education. Sometimes there are changes in curricula of the schools and the methodology that goes along with these changes. Therefore, there is need for the teachers to update their skills and knowledge to match with current developments in education.

The question is how will the teacher who completed his or her pre-service training more than a decade ago cater to these contemporary curriculum demands? How will the high school mathematics teachers, for instance, address the issue of facilitating a novel content of the high school mathematics? In-service education and training (INSET) may help to address these education concerns.



### **In-service Education and Training (INSET) for Mathematics Teachers**

Farrant (2004) defines in-service education and training (INSET) as a lifelong process in which the teacher is constantly learning and adapting to the new challenges of his or her job. Much of this training, according to Farrant (2004) is self-directed and is carried out by reading books and articles on education, by discussing with colleagues and supervisors matters concerning teaching and by attending courses and conferences on education. UNESCO (as cited in Adentwi, 2002) indicates that in-service training is training designed for teachers who are already in professional practice and which they receive in the context of or during period of varying length when their normal duties are suspended. Adentwi (2002) observes that the concepts of INSET underscore the need for all professional people to strive to acquire, on continuous basis, new ideas, skills, and attitudes to enhance their competencies and productivity and to effectively cope with inevitable changes that occur in the world of work. In-service training is accepted as an effective method of increasing the knowledge, skills and positive beliefs of teachers. It is a process used to continue the teachers' education once they have received their certifications in teaching and are employed in a professional position (Locke, 1984). From these definitions, in-service education and training (INSET) is intended to help and support the professional development and growth that teachers should experience throughout their work as teachers.

For example, in Nimba County (as in other counties in Liberia) the performance of candidates in the Liberia Senior High School Certificate Examination mathematics is reportedly far below average (WAEC, 2006). Specifically, WAEC has said the candidates are weak in the contents of

geometry and trigonometry. In order to remedy the situation, WAEC (2006) suggests that the teaching of geometry and trigonometry should be given consideration during the preparation of the candidates. From the point of view of the current researcher, issues about the content areas in mathematics which the candidates have reportedly performed poorly over time could be discussed at INSET programmes. Strategies that may help the students to overcome learning difficulties and to improve their skills in solving problems in geometry and in trigonometry may be devised by the mathematics teachers at the in-service education and training workshops.

Jackson (1982) asserts that the provision of opportunities for upgrading and continued professional growth of the teachers in Liberia is one way to improve the educational system in the country. Also, the Ministry of Education of Liberia (MOE, 2000) indicates that Liberia 1980 National Policy Conference on Education and Training supports the conduct of in-service education and training (INSET) in the country. The Conference specifically recommended that MOE should conduct annual refresher courses for teachers of mathematics, science, and English Language. However, this recommendation is yet to be implemented in Nimba County, where the study took place. For example, few of the selected schools in Nimba County organised and conducted INSET programs for their mathematics teachers once or twice in an academic year. These INSET activities received no support from the relevant education authorities of the county. INSET may be in the form of workshops, retreats, seminars, and symposia.

With regard to the effect of teachers' professional development on students' learning, a number of studies report that the more professional

knowledge teachers have, the higher the levels of student achievement (National Commission on Teaching for America's Future, 1997; Grosso de Leon, 2001). Also, according to Darling-Hammond (1999) investment in teachers' knowledge and skills net greater increases in students' achievement (in the US) than other uses of an education dollar. Loucks-Horsely and Matsumoto (1999) declare that teachers' professional development has great impact on students' achievement in mathematics and science. They indicate student learning is however not measured frequently enough when evaluating the impact of teachers' professional development. Borko and Putnam (1995) also assert that the professional development of the teacher plays an important role in changing teaching methods, and that these changes have positive impact on students' achievement.

INSET, in its most strict definition of courses for on-the-job learning, has also received a number of criticisms in the literature. Sharma (1992) declares that in most part of the world, the majority of in-service education and training programmes are too short, too unrelated to the needs of the teachers, and too ineffective to upgrade teaching knowledge. Moreover, INSET courses are theory-oriented and do not address practical concerns of the participants. Furthermore educators in charge of in-service courses are poorly prepared. Additionally there are few reading materials related to the field available to the teachers.

Sharma (1992) in the criticisms about INSET activities does not state how the concerns listed could be adequately addressed in order to improve students' achievement through empowering the teachers. However, with reference to the criticisms about the INSET activities, the present researcher

declares that INSET should be well planned, be given adequate time, courses should be more practical, and very competent and adequately prepared mathematics educators should be in charge of INSET programmes planned for teachers teaching mathematics.

### **The Training of High School Mathematics Teachers**

Stinnett (as cited in Kochhar, 2004) emphasizes that with good leadership and appropriate teaching aids, the teacher's effectiveness can be enhanced, but the most ingenious plans of administrators and the best array of instructional devices are of little avail if the teacher is ignorant, unskilled and indifferent. The type of training mathematics teachers receive is one of the key factors which determine students' achievement in mathematics, and indeed schools in Liberia, including senior high schools in Nimba County, are no exception. Of course, there may be other factors, which also influence students' achievement in mathematics in these senior high schools in the county.

For instance, there may be students' and their parents' demographics such as social-economic background of parents, the educational level and educational background of parents and so on which are likely to have influence on student achievement in their academic pursuit, including the study of mathematics. The emphasis, as far as the present study is concerned, is on the influence of teacher training status on student achievement.

Pope (1706) in his *Essay on Criticism* has said that little learning is a dangerous thing when he acknowledged ineffectiveness and inefficiency and the danger that they might cause people as a result of their refusal to read and learn continuously. One would relate this statement by Pope to a classroom

situation in which the teacher neither has the requisite knowledge of the subject matter he or she teaches nor knows the proper ways of teaching the content he or she intends to be a facilitator of.

To be a good facilitator of any subject, one should have a sound content based knowledge (Ball, Hill, & Bass 2005). Not only that, he or she should also have knowledge of the requisite methods of teaching in order to facilitate learning well. The teacher who has acquired broad knowledge and skills in teaching mathematics will to some extent foster the learning capacity of his or her students in mathematics [Shulman, 1986; National Research Council (NRC, 2001)]. Mathematics teachers may acquire the requisite knowledge and skills they need to effect positive changes in their student learning experiences through the training programs they attend.

Relating to challenges of education at the elementary and secondary levels in Liberia and the situational needs of these levels, Jackson (1982) declares that teacher education in Liberia must seek to:

1. equip teachers with the skills of adapting curricula and materials to provide for individual differences and varied environments.
2. develop those competencies (knowledge, skills, and attitudes) that will prepare teachers for effective functioning.
3. equip teachers with the professional competencies required for promoting functional learning and directing teaching and learning to higher levels of cognition as well as to dimensions of the affective.

In recent time the Liberian Teacher Training Programme (LTTP) helped teacher educators and teacher education institutions in Liberia to formulate “Standards” for the training of teachers in Liberia (Republic of

Liberia, 2007). These standards serve a directory role to be followed in training teachers in Liberia. These standards emphasise the following competencies as focus for training teachers in the country. These competencies for the training of teachers in Liberia include content knowledge, teaching skills, classroom management, student assessment and evaluation, and professional ethics and behavior (Republic of Liberia, 2007).

The Professional Standards for teachers in Liberia emphasise the following, among other things under content knowledge that the teacher:

- has sound knowledge of the content taught and a thorough knowledge of subject matter he or she teaches.
- has thorough knowledge of the National MOE curriculum and applies this effectively in teaching, making connections across subject matters where applicable.
- has knowledge of theories of child development and child psychology and applies these in teaching.
- has knowledge of approaches to teaching and learning and applies these in the classroom as appropriate.

Under Teaching Skills, the Standards stress that the teacher:

- is able to plan daily lessons with clear objectives as well as plan for the medium and long term.
- is able to break down the curriculum into meaningful topics according to the allotted instructional time.
- is able to make learning relevant and meaningful to students and relate it to their everyday lives by using real-life stories, local examples, and teaching aids.

With regard to Classroom Management, the Professional Standards for teachers in Liberia exerts that the teacher:

- makes sure that maximum time is spent on learning by getting and keeping students' attention , and by establishing routines to manage activities.
- ensures active participation by all students in class through effective questioning techniques and the use of individual, pair and group work.

In relation to student assessment and evaluation, the Professional Standards for Teachers in Liberia emphasise that the teacher:

- follows students' progress and monitors improvement over time as a result of instruction
- gives students frequent, constructive feedback on their performances in a timely manner
- monitors students' progress through the setting of quizzes, assignments, class participation and test.

In connection with professional ethics and behavior, the Professional Standards for Teachers in Liberia stress that the teacher:

- reflects on his or her own practice in order to continue to improve and continuously seeks opportunities for professional development.
- plans and executes his or her duties with diligence, commitment, dedication and fairness.

It may be correct to say that teacher's knowledge provides the basis for his or her effectiveness. So the relevant knowledge will be that which concerns the particular topic being taught and the relevant pedagogical strategies for teaching it to particular types of pupils. If the mathematics teacher, for example, is to teach percentage problems, then it is broad

knowledge of percent and closely associated topics which are major concerns. Similarly knowledge of teaching strategies relevant to teaching percentage problems will be important. In-service and pre-service professional development programmes may make a difference in developing this knowledge.

Castle (1971) observed that in the old days, teaching consisted of standing in front of a class of silent children and talking and writing on chalkboard. Learning was supposed to be listening to the teacher, copying from the blackboard and learning by heart. There was little speech except the talk of the teacher; there was no movement, little physical and mental activity. Kochhar (2004) also observes that teaching is too often considered to be a monologue and not a dialogue. Emphasis is laid on the subject-content but not on the learner. There has been a complete neglect of the student by the teacher to actively participate in the lessons. As a result of this neglect by the teacher, the student has become passive recipient of knowledge. A teacher who teaches student in this manner does so unconsciously. He or she teaches in this way because he or she lacks training and pedagogic knowledge and skills Kochhar (2004).

Some time ago, in Liberia, there were people who argued that teachers did not need training; that what they learned on the job was of far greater value than anything taught at the teacher training college or university. They believed that when someone completed an academic discipline he or she automatically qualified as a teacher. However this should not be the case.

This misconception about teacher preparation is being dispelled by some modern educators and researchers. For example, Farrant (2004) argues



that teachers, who have themselves only a limited general education or lack any teacher training, tend to have insufficient knowledge of what they have to teach to make it stimulating to their pupils. In some cases, too, their lack of knowledge causes them to teach incorrect facts. Some teachers use such formal and mechanical methods of teaching that children are put off learning and develop attitudes of hostility towards certain subjects (Farrant, 2004).

### **In-service Education and Training**

As stated earlier, pre-service training is an initiation to teaching. Therefore, pre-service training is inadequate to make the new teacher carry out his or her teaching tasks very well.

The question is, how will the teacher who completed his or her pre-service training more than a decade ago cater to these curriculum demands? For example, there have been reforms in the curricula of senior high schools in Liberia. These reforms call for innovations in teaching to align with new educational demands of the curricula. How will the high school mathematics teachers in Liberia, for instance, address the issue of facilitating a novel content of the high school mathematics? In-service education and training (INSET) is intended to help the teachers acquire additional skills and knowledge necessary for addressing new concerns arising in the curriculum and therefore in the classrooms.

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For example, in Nimba County (as in other counties in Liberia) the performance of candidates in the Liberia Senior High School Certificate Examination mathematics is far below average (WAEC, 2006). Specifically, WAEC has said the candidates are weak in the contents of geometry and trigonometry. In order to remedy the situation, WAEC (2006) suggests that the teaching of geometry and trigonometry should be given consideration during the preparation of the candidates. From the point of view of the current researcher, issues about the content areas in mathematics which the candidates have, every now and then, performed poorly could be discussed at INSET programmes. Teaching strategies that are necessary to help the students to improve their skills in solving problems in geometry and trigonometry may be devised by the mathematics teachers at the in-service education and training workshops. These strategies could be used by the mathematics teachers so as

to help the students overcome the difficulties they (students) experience in mathematics content areas.

Abdullai (n.d.) asserts that the way teaching was done in decades past is no longer the same way teaching is carried out today. She declares, therefore, that teachers should always participate in learning programmes that would improve their capabilities in the performance of their tasks so as to remain professionally alive. Specifically, Abdullai (n.d.) is quoted as saying, ‘A professional teacher realises that the materials and methods of yesterday are as inadequate to present or to meet the future needs of students, as in science and mathematics’ (pp. 12-13). Other veteran educators hold and express a similar view regarding the teacher’s update in skills and professional competence.

For example, Falade (2001) at the PANAFRICAN Conference of teachers in Johannesburg in South Africa states that the tools of yester years are no more relevant today. Teachers must update their skills and professional competence to make them relevant in their duties. He points out that there is need for teachers to develop themselves to avoid becoming “obsolete” and shamefully “outdated” in this computer age. On teachers’ quality and competence Falade (2001) emphasises that, “Teachers’ quality and competence cannot be compromised. To bestow quality, one must have quality.” This statement by Falade (2001) is parallel to the computer language GIGO, garbage in, garbage out: the idea a computer programme is as good as the information fed into it. Similarly in order to have quality learning in schools –especially elementary schools – in Liberia, the Ministry of Education

in Liberia has weeded the “volunteered” teachers whose academic level is below minimum of high school education.

With regard to the effect of teachers’ professional development on students’ learning, a number of studies report that the more professional knowledge teachers have, the higher the levels of student achievement (National Commission on Teaching for America’s Future, 1997; Grosso de Leon, 2001). Also, according to Darling-Hammond (1999) investment in teachers’ knowledge and skills net greater increases in students’ achievement (in the US) than other uses of an education dollar. Loucks-Horsely and Matsumoto (1999) declare that teachers’ professional development has great impact on students’ achievement in mathematics and science. They observe that student learning is however not measured frequently enough when evaluating the impact of teachers’ professional development. Borko and Putnam (1995) also assert that the professional development of the teacher plays an important role in changing teaching methods, and that these changes have positive impact on students’ achievement.

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Sharma (1992) however provides no suggestions to remedy and to improve INSET activities in order that they meet the goal of helping mathematics teachers (and teachers of other subjects) develop professionally. However the present researcher asserts that in-service education and training (INSET) activities for mathematics teachers should be well planned, should be given adequate time for implementation, courses should be mostly practical, and those in charge should be competent and adequately prepared mathematics educators.

In summary, the professional development of teachers is a prime factor in ensuring that reforms at any level of education are effective. Successful professional development opportunities for teachers have significant positive effect on students' performance and learning. Thus, when the goal is to increase students' learning and to improve the performance, the professional development and growth of the teachers should be considered a major factor Darling-Hammond (1999).

### **Methods of Teaching Mathematics**

Teaching is not a haphazard venture. It involves orderly and systematic process. Teaching is more than standing before a class and applying a few specific techniques. It is more than just presenting textbook information and then testing students' ability to repeat it. Teaching is not just writing lecture notes on the chalkboard and having the students to copy them in their exercise books. Teaching is involving and challenging.

Kochhar (2004) notes that teaching is not mechanical, but rather it is an intricate, exacting and challenging job. Effective teaching requires a variety of subject-content delivery techniques. Would-be teachers are exposed to

many different teaching methods during their training sessions at college or university. At their training sessions these teacher trainees are taught and encouraged to be creative in making provisions for individual differences among their students. These teacher trainees are encouraged to adopt and apply as many teaching techniques as possible that would cater to the needs of every student under their guidance.

Brophy and Good cited by Ellis (1992) acknowledge that effective teaching supports the use of a variety of teaching strategies. There are several different methods of teaching mathematics. Some of these methods of teaching mathematics are discussed below. They are teacher-centered methods; student-centered methods; and a mixture of teacher-centred and student-centered methods.

### **Teacher-Centred Method of Teaching Mathematics**

The teacher-centred teaching method is sometimes called talk-chalk method or traditional method. In the talk-chalk method of teaching mathematics, the teacher does almost all the talking. The students simply listen attentively and copy notes the teacher writes on the chalkboard. This method of teaching focuses on the subject but not on the students. The teacher lectures and demonstrates the lesson. The students passively receive knowledge from the teacher. The teacher using this method may understand mathematics though, but he or she teaches by telling and explaining ideas for solving problems to their students.

The teacher using the teacher-centred method of teaching mathematics believes that by merely telling and explaining ideas for solving problems, the students too would understand and be able to solve mathematics problems.

Teaching drives the learning instead of learning driving the teaching (Gattegno, 1970). Students are not actively engaged and challenged. They play the role of mere onlookers, quietly sitting and copying notes. They may simply memorise and not actually understand what they are supposed to be learning.

Gattegno (1970) calls this approach to teaching subordination of learning to teaching. Rote memorisation is a major product of this type of teaching. The students are not active participants in the teaching-learning process. By this traditional teaching method the teacher consider the students to be devoid of knowledge and ideas pertaining to the lessons. And as such the students are noted to have nothing to contribute meaningfully to their own learning (Gattegno, 1970).

The students are mere recipients of knowledge. Teacher-centred method of teaching mathematics is characteristic of the notion of the teacher having all the knowledge and understanding concerning mathematics. One key feature of the teacher-centred teaching strategy is its concern about how much of the lesson it should cover. The concern is not on how much of the curriculum the students should be able to understand and demonstrate. However learning has nothing to do with what the teacher covers. Learning has to do with what the student accomplishes (Gattegno, 1970). There are other methods of teaching mathematics. Another method of teaching mathematics is the student-centred method.

### **Student-Centred Teaching Approach**

The student-centred technique to teaching encourages learner's active participation in the teaching-learning process. The student-centred teaching strategy focuses on the promotion of learners' development. Gattegno (1970)

emphasises that teaching strategy which focuses on learners' development accelerates their learning and produces greater achievement in mathematics and all other subject areas. Learning drives teaching in the student-centred method of teaching. Gattegno (1970) terms this way of teaching as the subordination of teaching to learning. Learning gives direction to teaching in this case.

Mathematics is learned by doing mathematics. (Lindquist, 1990; Lappan & Schram, 1990; Oakes & Lipton, 2003; Krajcik, Czerniak, & Berger, 2003) declared that learning and understanding mathematics require learners' active participation in mathematics lessons. Gartrell (1998) also notes that students learn more effectively when they are doing and interacting.

Learning mathematics is a constructive rather than a passive activity. Mathematics teachers need to encourage students to use their past experiences to build new mathematical ideas. Students learn mathematics when they apply prior knowledge to build on new mathematical ideas. When students do not build on past mathematical experience to challenge novel mathematical problems, then they are simply receiving a body of knowledge. Such body of mathematical knowledge is often unrelated and unorganised. Being unrelated and unorganised these pieces of mathematical knowledge are difficult to retrieve and use.

Active learning by children has implications for the way mathematics is taught. Teachers need to create an environment that encourages children to explore, develop, test, discuss, and apply ideas. They need to listen to children and guide the development of their ideas. They need to make extensive and thoughtful use of physical materials to enhance the learning of abstract ideas.



Children are not little adults. They progress through various stages of development as they grow up. The abilities they possess and the characteristics they display change during the process of growing up; so do their interests and forces that motivate them; so also do their power of comprehension and self-expression (Farrant, 2004). Consequently, student-centred teaching tries to encourage teachers to do the following.

1. Teachers should select what is taught and methods used so they are appropriate to the comprehension and experience of the learners.
2. Teachers should apply the knowledge of child psychology and child development to the content and methods of learning and teaching.
3. It acknowledges that children's needs should determine what they learn at school.
4. The teachers should teach the students those skills that are within the capabilities of their stages of development (Farrant, 2004).

Mathematics teachers must tap on students' requisite previous knowledge of topics in mathematics. Making connections between what students already know and what they are to learn in a new lesson can help students to remember the new information. Carver and Klahr (2001) confirm that students' ability to remember new information about a subject depends considerably on what they already know about it. Consequently, learning should proceed from the known to the unknown; and from the simple to the complex. Teaching of materials to students should be done in stages. Whatever material is taught to a learner must be graduated and connected to the student's past experience.

Student-centred method of teaching mathematics significantly encourages the learners to communicate mathematically. Instead of having the students to be passive listeners as in the case of teacher-centred teaching strategy, learner-centred teaching technique engages the students to be active listeners. As learners listen attentively and get totally involved in whole class discussions, small group discussions and group presentations, asking questions and responding to questions, playing mathematics related games and the like, they tend to better understand mathematics lessons.

Student-centred teaching technique helps to foster learners' thinking strategy. For example, the emphasis on creating or inventing relationships encourages students to view mathematics as an activity that makes sense. According to Cobb and Markel (1990) teaching thinking strategies helps learners view mathematics as an "activity that is supposed to make sense rather than one that involves memorised rules" (p. 71). Teacher-student as well as student-student interactions are important aspects of teaching-learning process. These interactions among teacher and students as well as among students and students in mathematics help to foster students' learning and understanding of the subject.

The students have been taught how to add two like fractions as well as how to add two unlike fractions, for example. Given that the lessons on the two topics are not yet thoroughly understood, when given two simple, unlike fractions to add, these students may have misconceptions. As a result of their misconceptions, these students may add the numerators of the unlike fractions and express the sum over a single denominator just as they did in adding the two like fractions. Getting the students to share their ideas about how they

arrive at answer to the fraction problem may help to correct their misconceptions about adding unlike fractions. Also getting some volunteer students from the class to work the problem on the chalkboard will help the teacher to see clearly where the misconceptions lie.

The teacher may then reinforce the students' understanding of the lesson by correcting their misconceptions about adding simple, unlike fractions. The teacher could do this by solving the problem on the chalkboard and again explaining to the students the process required in order to arrive at the answer. The teacher could also get the students to work at the problem in small groups. The group members will then collaborate and coordinate their concerted efforts to solve their common problem. Group leader would then present group work to the class. Students learn a lot of mathematics when they work this way.

Johnson and Johnson (1994) state that if mathematics instruction is to help students think mathematically, understand the connections among various mathematical facts and procedures, and be able to apply formal mathematical knowledge flexibly and meaningfully, cooperative learning must be employed in mathematics classes. There are several reasons why students should be challenged to work on a problem together in cooperative groups. Some of these reasons are listed below and explained below.

First, mathematical concepts and skills are best learned as a dynamic process with the active engagement of students. Mathematical learning should be active rather than passive. Traditional mathematics instruction has been based on the assumption that students are passive absorbers of information who, as a result of repeated practice and reinforcement, store what they know

in easily retrievable fragments. Active learning requires intellectual challenge and curiosity, which are best aroused in discussions with other students.

Second, Mathematical problem solving is an interpersonal enterprise. Talking through mathematics problems with classmates helps students understand how to solve the problems correctly. Students are also required to use the language of mathematics. Having to explain one's reasoning allows classmates (and the teacher) to check assumptions, clarify misconceptions, and correct errors in understanding and applying mathematical principles. Students have more chances to explain their reasoning and are more comfortable doing so in small groups than in whole class discussions.

Third, mathematics learning groups have to be structured cooperatively to communicate effectively. Within competitive and individualistic structures, students will not engage in the intellectual interchange required for learning mathematics. Their tendency is to cut off communication, to avoid sharing analysis and strategies with each other.

Fourth, cooperation promotes higher achievement in mathematics than competitive and individualistic efforts. When students engage in competitive individual work, they may act selfish, not sharing knowledge and ideas and not caring for the progress of other students in the class.

Fifth, by working cooperatively, students gain confidence in their individual mathematical abilities. They receive encouragement and support from group members in their efforts to learn mathematical processes, strategies, and concepts.

Slavin (as cited in Santrock, 2006) observes that cooperative learning can be an effective strategy for improving achievement, especially when two conditions are satisfied:

1. Group rewards are generated. Some type of recognition or reward is given to the group so that the group members can sense that it is in their best interest to help each other learn.
2. Individuals are held accountable. Some method of evaluating a student's individual contribution, such as an individual quiz, needs to be used.

Without this individual accountability, some students might do some social loafing (let other students do their work) and some might be left out because it is believed that they have little to contribute. Hoyles (as cited in Lappan and Schram (1990) has found that different aspects of "student-student discussion can facilitate a student's integration of her fragmented knowledge" (p. 16). Listening is an integral part of teaching-learning process. Listening requires students' active participation during class discussions.

During class discussions, the ideas of others can suggest modifications to one's own thoughts clarify half-worked out predictions or explain half understood processes. This is an indication that learners' problem-solving strategies can be enhanced by discussing ideas and fine-tuning their explanations. Students learn from one another as they work cooperatively in groups; and as they talk and listen. The teacher must encourage students to talk and discuss mathematics in the classroom.

Classroom discussion can give teachers an excellent assessment of how the students are thinking and what they know. Receiving information is very different from transmitting it. Students may think they understand an

idea, but inconsistencies in thinking may become apparent when they are asked to explain their thinking or to tell why they think their answer is correct. Cobb and Markel (1990) emphasise that the practice of having students explain their solutions to problems also allows them to realise that problems can be solved in more than one way and improve their ability to verbalise their thinking.

### **Mixture of Teacher - Centred and Student - Centred Methods**

Another method of teaching is the mixed method or the blended teaching technique. This method of teaching employs the blend of student centred teaching strategies and teacher-centred instruction strategies. The blended instructional method is based on the concept that no one teaching strategy is the best teaching technique. According to Capel, Leask, and Turner (2005) no single teaching style is more or less important than another; what is important is that the teacher appreciates the potential of the different styles and can move between them as circumstances demand. Goldberger (as cited in Capel, Leask, & Turner, 2005) describes the shifting of teaching styles to meet learner objectives as mobility ability – ‘the ability to shift comfortably from one teaching style to another in order to meet learner objectives’ (p. 285). The implications of using various teaching styles are for the teachers to bridge the method gap by employing and utilising a variety of teaching strategies appropriately. Teachers must make provision for individual differences in terms of applying many teaching methods that would take care of the instructional needs of every student.

Individual students are different in terms of the ways and conditions under which they learn best. Therefore, the teachers should provide the

necessary learning environment for each of these learners. Creating the necessary learning environment would help to facilitate teaching and learning. Having the necessary learning environment to facilitate teaching and learning would help to foster students' achievement in mathematics. Whichever method of teaching is used, assessment plays a vital role and should be mentioned as part of teaching any teaching method.

Assessment of students' academic performance in mathematics is an integral part of the teaching and learning process. In the absence of such assessment results for each learner the mathematics teacher would not be able to determine how well he or she is facilitating instructions in the subject. Without assessment results for the students the teacher would not know how well the students are doing in the subject. Without assessment results the teacher would not be able to determine what course of action to consider in effecting certain instructional decisions.

McMillan (1997) asserts that competent teachers frequently assess and evaluate their students in relation to learning goals and adapt their instruction accordingly. Adapting instruction to the needs of the learners would enhance their understanding and improve their performance. Adequate assessment results would help to provide relevant instruction. It is in the provision of relevant instruction the subject-content and teaching methods are integrated into planned instructional activities designed to help students achieve the desired learning outcomes. Gronlund (1976) states that during the instructional phase, testing and evaluation provide a means of:

- monitoring learning progress, and
- diagnosing learning difficulties.

Thus, periodic evaluation during mathematics instruction provides a type of feedback-corrective procedure that aids in continuously adapting instruction to group and individual needs. The final step in the instructional process is to determine the extent to which the instructional objectives have been achieved by the learners. This is done by utilising tests and other evaluation instruments that are specifically constructed to measure the intended learning outcomes. Gronlund (1976) declares that properly used evaluation procedures can contribute directly to improved students' learning by the following means:

- clarifying the nature of the intended learning outcomes,
- providing short-term goals to work toward,
- providing feedback concerning learning progress, and
- providing information for overcoming learning difficulties and for selecting future learning experiences.

Although these purposes are probably best served by the periodic evaluation during instruction, the final evaluation of intended learning outcomes should also contribute to these ends. Information from carefully developed evaluation techniques can also be used to evaluate and improve instruction. Such information can help in judging the following:

- the appropriateness and attainability of the instructional objectives,
- the usefulness of the instructional materials, and
- the effectiveness of the instructional methods.

Thus, evaluation procedures can contribute to the improvements in the teaching-learning process itself, as well as contributing directly to improved students' learning. Evaluation results are, of course, also used for assigning



marks and reporting student progress to parents or guardians. In addition to the methods and evaluation strategies that have been discussed above, would be teachers are trained in how to prepare for lessons to take into account the benefits of making mathematics lessons interesting and effective. Thus effective planning plays a major part in the achievement of students in the teaching-learning process.

### **The Significance of Subject Specialisation and Qualification of High School Mathematics Teachers**

In addition to training high school mathematics teachers, literature has also shown that mathematics teachers' subject specialty and teachers' qualifications have significant influence on high school students' achievement in mathematics. National Study Council (2001) observed students who were taught by teachers with certificates in mathematics out performed on the NAEP Mathematics tests, than students whose teachers had certificates in other fields. The finding suggests that teachers' subject specialisation and mastery are crucial in students' learning of the subject. Work by other researchers and institutions also supports that teachers' qualification and subject-content specialisation influence students' learning outcomes.

Darling-Hammond and Ball cited by Ama and Ama (2004), observe that teacher expertise—or what teachers know and can do—affect the entire core tasks of teaching. For example, what teachers understand both about content and students, give rise to how they select texts and other instructional materials and how effectively they present the materials in the class. The National Commission on Teaching and America's Future (1996) asserts that

one factor that can make a difference in improving students' achievement is knowledgeable, skillful teachers.

UNESCO (2004) emphasises that "if teachers are the centre of education, they need to be of good quality and sufficient in numbers" (p. 5). Education For All (EFA, 2002) reaffirms that the "quality of teaching significantly affects student achievement, particularly in terms of teaching methods, subject-specific expertise, motivation and attitude" (p. 24). UNESCO (2006) stresses that, "If children are to receive quality education, they need qualified, competent and committed teachers" (p.9). Rod Paige, the United States Secretary of Education, also supports that qualified teacher is the most important ingredient in ensuring a quality education. Apart from subject-content specialty and teacher qualification, other factors may influence high school students' achievement in mathematics. One of such variables is years of teaching experience of the teacher.

### **Years of Teaching Experience**

Teachers may spend different length of years teaching in the classroom. These years the teacher spends teaching in the classroom are the teachers' years of experience. There is no agreement yet concerning teachers' years of experience and how they relate to students' achievement in mathematics. Different researchers have expressed varied views concerning the topic. Murnane and Phillips (1981) notes that the relationship between student learning and teachers' effectiveness and their years of experience is not always significant one or an entirely linear one. But there is a common saying that practice makes perfect. This saying is supported by some researchers in mathematics education. Rosenholtz (1986) for example, argues

that while inexperienced teachers (those with less than three years of experience) are typically less effective than more senior teachers, the benefits of experience appear to level off after about five years, especially in non-collegial work settings. As a beginning teacher teaches the same subject over a certain period of time, he or she may begin to gain ideas of teaching that would make him or her become an effective teacher.

In some instances the veteran teachers may continue to gain more experience. Sometimes the benefits of experience may interact with educational opportunities. For instance, veteran or more experienced teachers in settings that lay emphasis on continual learning and collaboration continue to grow and improve their own performance. Similarly, a well-prepared beginning teacher can be highly effective. Andrew and Schwab (1995) found that long-lasting teacher development programmes yielded better results than short-term teacher training programmes. According to them, five-year teacher education programmes – programmes that included a bachelor's degree in the discipline and master's in education as well as a year-long student teaching placement-have found graduates to be more confident than graduates of four-year programmes and as effective as more senior teachers. Here, long-term teacher preparation, solid-content based knowledge, pedagogy, and long-term teaching practice- all play key role in making the teachers highly effective.

More knowledgeable teachers in educational settings with no opportunities for staff development may become stagnant in their performance. Age also plays a major role in the performance of teachers. For example, older teachers do not always continue to grow and learn. They may grow tired in their jobs. In addition to the years of experience of the

mathematics teachers, other factors may be crucial in the achievement results of the students they teach. One of such factors is the methods of teaching mathematics.

### **Research on Mathematics Teacher Training and Student Achievement**

In spite of the apparent benefits of teacher training discussed above, there are diverse views of various researchers about the effect of teacher training on the achievement of their students. Some researchers argue that the training of mathematics teachers contributes very little to student achievement in mathematics. Wiley and Yoon (1995) and Cohen and Hill (2000), for example, find teacher development programmes to have relatively small effect on student performance. Harris and Sass (2007) also point out that teacher training generally has little influence on productivity. However, content-focused teacher professional development is particularly associated with productivity in middle and high school mathematics (Harris & Sass, 2007).

Despite the findings of Wiley and Yoon (1995), Cohen and Hill (2000), research work by other mathematics educators have found that the training of mathematics teachers has maximum effects on student achievement in mathematics. For example, Bressoux (1996), using a quasi-experimental design, and Dildy (1982), examining the results of a randomised trial, found that teacher training increases student performance.

In recent times the Liberian government through the Ministry of Education implemented a major education policy which reflected the academic achievement of those who should teach in Liberia. Before then there were many senior high school graduates as well as senior high school dropouts who “volunteered” their services by teaching in primary and junior secondary schools which had no teachers assigned to them, especially public schools in

rural areas of the country. With the introduction of the new policy on education, the government of Liberia through the Ministry of Education has started paying these “volunteer” teachers. It further screened those teachers laid off those who were not senior high school graduates and maintained the senior high school graduates for subsequent teacher training. The idea of the training is to prepare these senior high school graduates in pedagogy and in subject-content areas. Training helps to improve the subject matter knowledge and the professional skills of the teacher. Training must therefore be a continuous process.

Education officers in Liberia have always expressed that there is an effect of training of teachers on the achievement of students in various subject areas, especially in mathematics. These views of the education officers in Liberia reflect some relevant research findings. Angrist and Lavy (2001), for example, observed that there is a strong relation between teacher training and student achievement in mathematics. Studies by other researchers have also indicated a stronger and more consistent positive result of professional education coursework on teachers’ effectiveness, which leads to better student achievement. Similarly, Ashton and Crocker (1987) reported that a significant positive relationship exists between education coursework and teacher performance.

The acquisition of pedagogical-content knowledge by the teacher is an essential aspect of his or her training and professional development. Pedagogical-content knowledge of mathematics is found to be especially one major tool that gets the mathematics teacher to perform well and the student to achieve more in mathematics (Shulman, 1986). For example, Begle (1979) found that the number of credits a teacher had in mathematics methods courses was a strong correlate of student performance than was the number of

mathematics courses or other indicators of teacher preparation. In a similar vein, Monk's (1994) study of student's mathematics and science achievement found that teacher education coursework had a strong positive effect on student learning and was sometimes more influential than additional subject matter preparation. Denton and Lacina (1984) also noted positive relationships between the degree of teachers' professional coursework and their teaching performance.

More often, some schools in Liberia conduct workshops for their teachers at the beginning of every academic year. Key among the objectives of these teacher workshops is to make the teachers "grow and continue to grow professionally." The workshops take place in schools in the various counties including those in Nimba County. The present researcher believes that the mathematics teacher must grow both in subject content knowledge and professional skills. These two things "academic proficiency and professional development and growth" must go together to make mathematics teacher strong in his or her discipline. The two things would empower the mathematics teacher and teachers of other subjects to be well-prepared to effect positive changes in the achievement of the students.

Several recent studies (e.g. Goulding, Rowland, & Barber, 2002) have found that higher levels of student achievement in mathematics are associated with mathematics teachers' opportunities to participate in sustained professional development programmes grounded in content-specific pedagogy. Content-specific pedagogy helps the teachers to be able to link the subject-content to the more professional ways the subject should be taught for the benefit of the learners' instructional needs. This means that the extent of professional development matters for teaching and for student achievement.

## Summary

No one teaching method is the best method. Learners are different in terms of the way each learner learns best. So, the mathematics teachers must use as many different teaching methods as possible. The mathematics teachers must tap on their students' past mathematical knowledge to help these students learn new materials in mathematics. Engage students in more hands-on activities in the mathematics classes. There are different views and reports on the training of mathematics teachers and its effects on student learning outcomes in mathematics. The findings of different researchers on the relationship between teacher training, teacher qualifications, teacher specialisation, teacher's years of teaching experience and student achievement in mathematics differ among these researchers.

Some researchers in mathematics note that student achievement is a function of teacher training programmes, at least. Researchers grounded in this view observe that when teachers of mathematics are well-trained the students they teach will achieve more in their mathematics lessons. These researchers have found these variables to be very significant in producing desired students' learning outputs. As one would expect, other researchers argue that the above variables have very little effect on students' learning outcomes.

The differences in the research findings regarding teacher training and student achievement provides a useful platform for the investigations covered in the present research. Chapter Three looks at the methodology of the research.

## **CHAPTER THREE**

### **METHODOLOGY**

This chapter focuses on the way the research study was set up and conducted. It gives the type of study design and indicates the population from which the sample was drawn. It further indicates the method of selecting the sample from the population and the sample size for the study. The chapter further gives the types of instruments used in the research. It also gives how the research instruments were developed and validated, and it states how reliable the instruments are. It explains how and where the instruments were pilot tested. It further gives reasons why the research instruments were pilot tested in the place mentioned. Finally, the chapter discusses how the data for the research were collected and the data analysis procedure.

#### **Research Design**

The descriptive method of the survey type was employed in conducting the research work. This design was used because of the nature of the research. The research used both quantitative and qualitative methods. As Creswell (1994) points out, qualitative study is an inquiry process of understanding a social or human problem, based on building a complex, holistic picture, from a natural setting. The study was designed to enable the researcher to report what actually exist and not to manipulate any variables.



### **Population of the Study**

The targeted population of the study comprised all twelfth grade students currently enrolled in the senior high schools in Nimba County. All twelfth grade mathematics teachers also formed part of that targeted population.

### **Sample**

Five out of twelve educational districts in Nimba County were purposively selected for the research work. There were a total of thirty-one senior high schools in those twelve educational districts. The five school districts selected had twenty-five senior high schools. Fourteen of those twenty-five high schools were used for the study.

The sample of this study consisted of two hundred and ninety respondents. This number comprised two hundred and eighty twelfth grade students from the fourteen senior high schools and ten teachers from ten of the schools. Twenty twelfth grade students from each of those fourteen high schools were considered for the research study. A total of two hundred and eighty twelfth grade students comprising one hundred seventy-three boys and one hundred and seven girls were sampled for the study. Ten mathematics teachers, all males, constituted the teacher component of the sample. Six senior high schools in the county had one mathematics teacher each teaching there. Each of the other four mathematics teachers taught in two of the remaining eight senior high schools.

### **Sampling Procedure**

There are thirty-one complete senior high schools in Nimba County. Twenty of these schools were purposively considered for the research work. However, only fourteen of them were actually used in the study. Thus the twelfth grade mathematics teachers of these fourteen senior high schools also

formed subjects of the study. On the average twelfth grade classes of the fourteen senior high schools in Nimba County had a minimum of fifty students and a maximum of sixty-five students. A random sample of twenty students was selected from each of these senior high schools. The selection of the sample for the research study was carried out using the table of random numbers.

The researcher obtained roster or register of twelfth grade students in each senior high school from the mathematics teacher through the principal of the school. The class roster was then numbered vertically, starting with the first name on the student roster, using two digits. This numbering began with 01 and continued orderly with 02, 03, without skipping a digit and ended at 65. An arbitrary entry point within the table of random numbers was used as a starting point. The first two columns of the table of random numbers were then applied to the class roster of twelfth grade students at the school. A twelfth grade student at the school was selected as a subject for the study if the number against his or her name on the class roster corresponded with the number on the table of random numbers.

The purpose of drawing a sample from a population was to gather information concerning that population. It was therefore important that the individuals included in a sample constituted a representative cross section of individuals in the population. In order to have a representative cross section of individuals in the population, a combination of quota sampling and the simple random sampling techniques were applied.

Ary, Jacobs, and Razavieh (2002) say sample must be representative if you are to be able to generalize with confidence from the sample to the population. How large should a sample be is not a major concern in the

conduct of a research work. The most important feature of a sample is its representativeness of the population, not its size. By representativeness we mean that our sample is similar, in all major aspects, to the overall population from which it is taken (Ray, 2003). For example, as the researcher was interested in finding out about achievement in different schools, he could not use a simple random sample procedure alone. If he did there would be the possibility that some schools would not be represented at all. This is why a combination of quota and simple random sampling procedures were utilised to help make the selection of the sample more representative. In other words, each school was give a quota of twenty students and simple random sampling was used to select twenty students from each school.

### **Instruments**

The research used two different types of research instruments. These instruments were questionnaires and data sheets. The use of questionnaires and data sheets was chosen because of their being less costly and less time-consuming. The questionnaires were designed for two different categories of respondents. One set of the questionnaires was constructed to gather information from twelfth grade students attending selected high schools in Nimba County. Information needed from the students related to the twelfth grade mathematics teachers' style of teaching mathematics. The questionnaires for twelfth grade students were constructed using five points Likert scaled items, rating from 1 to 5 inclusive. For example, students' questionnaires had the following responses to each item: 1 Never; 2 Rarely; 3 Sometimes; 4 Often; and 5 Always. The other questionnaire - teacher background survey questionnaire - was designed to obtain background information directly from the twelfth grade mathematics teachers themselves.

Unlike the students' questionnaires, which had 5 items per question and with similar themes, the mathematics teachers' background survey questionnaire was not homogeneous: some questions on the teacher questionnaire had 6 items; some had 5 items, while others had 2 items with somewhat different themes. For this reason, the reliability of the teacher questionnaire was found in parts. For instance, the reliability coefficient of the questions with 6 items was found. Also the reliability coefficient of the question with 5 items was determined. Then the reliability coefficient of the questions with 2 items was found. The average of these reliability coefficients was given as the estimate of the overall reliability coefficient of the teacher questionnaire. Initially, the students' questionnaire contained sixty-seven items. Some research colleagues helped to modify the questionnaire and reduced the items to fifty-four. Thereafter the researcher took the questionnaire to the thesis supervisor who further modified it. Finally, the twelfth grade students' questionnaire contained twenty-three items.

Data sheets were prepared and used to gather previous twelfth grade students' LSHSCE mathematics assessment results over a four-year period (2004/05-2007/08) inclusive.

### **Pilot Testing of Instruments**

Prior to collecting data for the study the researcher pilot tested the instruments. Best & Kahn (1993), Bell (2005), and Saunders, Lewis, and Thornhill (2007) advised researchers to pilot test their questionnaires with a small group of subjects similar to those who would be used in the study.

Both questionnaire for the twelfth grade students and the questionnaire for twelfth grade mathematics teachers were pilot tested in two senior high schools in Central Region of Ghana in November 2008. The students' questionnaire was pilot tested on 53 twelfth grade students comprising 34 boys

and 19 girls. The teachers' questionnaire was pilot tested on two teachers teaching twelfth grade mathematics. The reliability coefficient (Cronbach's alpha) of the students' questionnaires was found to be .784. The reliability coefficient of the teacher's questionnaire was .705 and the reliability coefficient of the data sheet was .659. The Statistical Package for Social Sciences (SPSS) was used to determine these reliability coefficients given above.

The two senior high schools in which the instruments were pilot tested were the Liberia Refugee Community High School in Buduburam and the New Testament High School located at Kasoa-Winneba Road. These two schools were used to pilot test the instruments because they both have features identical to senior high schools in Liberia where the actual research was carried out. For example, majority of the students attending these selected senior high schools in Ghana were Liberians. Also, the teacher teaching twelfth grade mathematics at Buduburam Community High School was a Liberian. Again, the mathematics syllabus for the selected senior high schools has similar contents as the mathematics syllabus for senior high schools in Liberia. Furthermore, the twelfth grade students in the selected high schools write similar terminal high school mathematics examinations administered by the same examining body (WAEC). So pilot testing the instruments in these schools in Ghana was like pilot testing them in high schools in Liberia.

### **Procedure for Data Collection**

Before administering the research study instruments in Liberia, the researcher obtained a letter from the Deputy Minister for Instruction, Ministry of Education, in Monrovia. The letter introduced the researcher to the CEO, DEOs, Principals, teachers and students of high schools in Nimba County, where the study was carried out. Upon receiving the letter from the minister's

office, the researcher went to the CEO of Nimba County School System office in Sanniquellie, the capital of Nimba County. Thereafter the researcher visited each selected school in Nimba County. That visit created awareness. Each school was informed about the study. The twelfth grade mathematics teacher and the principal of each senior high school made a schedule for the researcher. The schedule indicated the day, date and time the researcher would return to carry out the study at the school which was followed strictly. The researcher distributed questionnaires to the randomly selected twelfth grade students and collected the questionnaires right after their completion. Thereafter, the researcher gave the twelfth grade mathematics teacher a copy of the teachers' background survey questionnaires. That too was collected immediately upon its completion by the teacher.

The researcher used the data sheets to gather LSHSCE mathematics results for previous twelfth grade students of the schools. The scores were collected over four consecutive academic years: 2004/05, 2005/06, 2006/07 and 2007/08. The scores were collected in two phases. In the first phase the scores from each school were obtained from the principal of that school. During the second phase, the scores were obtained from the research section at WAEC head office in Monrovia. The data sheets were also used for that purpose. Finally, same school LSHSCE mathematics results on the two data sheets were compared and cross checked to make sure that there were no discrepancies in the two results. Cross-checking will verify the data. Patzer (1996) points out that where data from two or more independent sources suggest similar conclusions, you can have confidence that data on which they are based, are not distorted. On the other hand where data suggest different conclusions you need to be more careful of the results.

The researcher planned to collect twelfth grade LSHSCE mathematics results for at least five consecutive academic years. However, this was not possible. Most of the senior high schools did not have LSHSCE results for academic 2003/04 and below. Besides, WAEC Monrovia office did not have complete examination results for 2003/04 and below for many of the schools in Nimba County where the research was conducted.

### **Data Analysis**

The data collected for the research were coded and made ready for analysis. The data were analysed by means of simple proportion and simple percentages. One Way Analysis of Variance (ANOVA) was also used to find whether there were significant differences between high school mathematics:

- teacher training status and students' achievement;
- teacher qualification and students' achievement;
- teacher specialisation and students' achievement;
- teacher years of teaching experience and students' achievement.

ANOVA could not, however, give details concerning differences where they existed so the Duncan multiple-range test was used to obtain detailed information about the differences. The Statistical Package for Social Sciences (SPSS) gave the outputs of the ANOVA and the Duncan multiple-range test.

The data meets parametric assumptions of the ANOVA. The analysis and result obtained from the analysis are discussed in Chapter Four.

## **CHAPTER FOUR**

### **RESULTS AND DISCUSSION**

This chapter deals with the presentation of the data collected from the field. The chapter focuses on the analysis and the interpretation of these data with the view to answering the research questions stated in chapter one. The results are presented first and then discussed in later section.

Research Question One: Do high school students perceived the teaching style of their mathematics teachers as ‘teacher-centred, student-centred, or both’?

Table 1 presents the views of twelfth grade students of the selected senior high schools in Nimba County concerning teaching approaches used by the mathematics teachers in these schools. The views of the students were analysed in relation to addressing Research Question One. In the questionnaires the students were asked to indicate the extent to which the mathematics teachers involved them in the mathematics lessons in the classes. Also, the students’ responses to another question in the questionnaires reveal how the teachers reacted to questions posed by the students in the mathematics classes.

Table 1 also contains students’ responses to a question which sought information about whether the mathematics teachers were delivering the mathematics lessons for students’ understanding or for coverage of the subject-contents. The summary of the students’ responses to key questions in the questionnaires, the frequencies of the students’ responses and their



corresponding percentages are provided in Table 1. The analysis obtained from Table 1 of students' responses to the questions addresses Research Question One.

**Table 1: High School Students' Perception of Mathematics Teachers Teaching Style**

Item	Rating			Total
	1-2	3	4-5	
Allows me to ask questions	8 (2.9)*	32 (11.4)	240 (85.7)	280 (100)
Explains and makes sure I understand past lessons	14 (5.0)	46 (16.4)	220 (78.5)	280 (100)
We work in small activity groups	157 (56.1)	65 (23.2)	58 (20.7)	280 (100)
Teacher uses a variety of TLA	160 (57.1)	51 (18.2)	69 (24.7)	280 (100)
Teacher uses simple words to teach	17(6.0)	38(13.6)	225(80.4)	280(100)
Relates new lessons to past lessons	37(13.2)	46(16.4)	197(70.3)	280(100)
Gives uses of math in other subjects	101(36.0)	46(16.5)	133(47.5)	280(100)
Teacher uses extra time to prepare me	52(18.5)	52(18.5)	176(63.0)	280(100)
Marks and returns my papers on time	10(3.5)	47(16.8)	223(79.7)	280(100)
Teacher reviews home work, quizzes, tests, etc.	20(7.1)	42(15.0)	218(77.9)	280(100)

\* Note: Each number in a parenthesis is a percent.

Table 1 reveals that as many as 240 (85.7%) of the students indicated that the mathematics teachers encourage them to ask questions in the mathematics classes while 8 (2.9%) of the students reported that the

mathematics teacher hardly ever or never allow them to ask questions in the classes. Table 1 also shows that 220 (78.5) of the students responded that the mathematics teacher made sure majority of them understood previous mathematics lessons before he went on to teach new lessons. Table 1 further reveals that 46 (16.4%) of the students indicated that at times the teacher made them understand previous mathematics lesson before he proceeded to a new lesson. With regard to working in groups, Table 1 shows that 157 (56.1%) of the students said that the mathematics teachers hardly ever or never challenged them to do mathematics in small activity groups. Again according to Table 1, 160 (57.1%) of the students declared that the mathematics teachers hardly ever or never used a variety of teaching-learning aids to teach them mathematics. On the other hand, 69 (24.7%) of them said the mathematics teachers use various teaching-learning aids to teach them mathematics.

In relation to the mathematics teachers clarity of language, Table 1 reveals that as many as 225 (80.4%) of the students declared that the mathematics teachers use simple words to teach them while 17 (6.0%) of the respondents reported that the teachers hardly or never use words at their level to teach them mathematics. Regarding the extent to which connections were made between the current mathematics lessons and past mathematics lessons, 197 (70.3%) of the students responded that the mathematics teachers made connections between current mathematics lesson and previous mathematics lessons. However 37 (13.2%) of the students declared that the mathematics teachers seldom or never related new mathematics lesson to previous mathematics lessons. Considering how mathematics could be used in other subjects, 133 (47.5%) of the students reported that mathematics teachers gave

the uses of mathematics in other subjects like physics, chemistry, biology, geography, among others. On the other hand 101 (36.0%) of the students, however, argued that the mathematics teachers made no interdisciplinary connections.

The students' opinion about the manner in which the mathematics teachers conducted the classes is also given in Table 1. Table 1 indicates that 176 (63.0%) of the students said the teachers devoted extra time to help them improve their mathematics problem-solving skills and ability to succeed in the LSHSCE mathematics. Table 1 also shows that 52 (18.5%) of the students indicated that the teacher occasionally used extra time or never used extra time to assist them improve their mathematics skills. With regard to how the mathematics teachers assessed and reinforced students' learning of mathematics, Table 1 shows that more than 75.0% of the students affirmed that the teachers marked and returned their homework papers, test papers, quiz papers, and other papers on time. Also, Table 1 reveals that as low as 10 (3.5%) of the students, however, argued that the teachers seldom or never marked and gave back their quiz or test papers on time.

Finally, in Table 1, 218 (77.9%) of the twelfth grade students declared that the teacher reviewed their homework, quiz, and test questions before he began fresh mathematics lessons while 20 (7.1%) of them maintained that the mathematics teacher either rarely or never review homework, quiz, and test questions before he started new lessons.

In sum Table 1 reveals that 176 (62.8%) of the twelfth grade students in the selected schools in Nimba County perceive the mathematics teachers' style of teaching mathematics as being good practice as it encourages student-

centred approaches while 58 (20.6%) viewed the mathematics teachers' teaching style as not good practice as it encourages teacher-centred approaches. Generally, Table 1 indicates that the students perceive the mathematics teachers' teaching style as containing both student-centred and teacher-centred approaches.

The next section of the study deals with the mathematics teachers' views about the provision of in-service education and training (INSET) programs for the teachers teaching high school mathematics in the selected high schools in Nimba County. Also, this section of the study responds to Research Question Two: How do the mathematics teachers perceive the provision of INSET in Nimba County in the post war era?

Tables 2, 3, 4, 5, 6, and 7 were used to address Research Question Two.

**Mathematics Teachers Perception of Provision of INSET in Nimba County Post War era**

The item asking about teachers' perception of in-service teacher training (INSET) aimed at finding out if teachers thought in-service training was a vital component of teacher development. Table 2 shows the responses received from the ten teachers who took part in the study.

**Table 2: Teachers' Perception of Whether In-service Teacher Training is good for Development**

Extent of agreement	Frequency	Percentage
Undecided	1	10.0
Agree	7	70.0
Strongly Agree	2	20.0
Total	10	100.0

Table 2 reflects the views of the mathematics teachers of the selected high schools in Nimba County concerning in-service teacher training workshops and their ability to support teacher development. The data show that 9 (90.0%) of the mathematics teachers responded that in-service teacher training workshops were a necessary component of teachers' continuous professional development programmes. The teachers agreed that in-service teacher training workshops could help them to improve the professional teaching skills of teachers.

Table 3 shows mathematics teachers' responses to whether or not in-service teacher training workshops were organised for them to attend.

**Table 3: In-service Teacher Training Workshops are Organised for me to Attend them.**

Attendance of Inset	Frequency	Percentage
Never	4	40.0
Rarely	0	0.0
Sometimes	1	10.0
Often	2	20.0
Always	3	30.0
Total	10	100.0

In Table 3, 50.0% of the teachers teaching mathematics in the high schools said that they attended in-service teacher training workshops organised for them while 40.0% of them responded that no in-service teacher training workshops were organised for them to attend.

The responses to who sponsored or organised in-service teacher training workshops in Nimba County reveal that all the in-service teacher training workshops except one were sponsored by individual schools. Central Administration sponsored only one of the workshops and none was sponsored by the local community school system, the Ministry of Education or non-governmental organisations (NGO).

Responses to an item on the time allotted for the running of in-service teacher training workshops are organised in Table 4. It describes the pattern of occurrence or the intervals between the times in-service teacher training workshops are run.

**Table 4: Interval, Frequency and Percentage Distribution of In-service Teacher Training Workshops**

Time Scale	Frequency	Percentage
None in a year	4	40.0
Once a year	5	50.0
Once a semester	1	10.0
Total	10	100.0

Table 4 shows that 60.0% of the mathematics teachers had, within a year, attended in-service teacher training workshops which were run on a yearly or semester basis. Of those who had attended an in-service teacher training workshops within a year, 1 (16.7%) of them had it once a semester and 5 (83.3%) of them had had it once within an academic year.

The mathematics teachers were asked how long the teacher training workshops they attended lasted for. Their responses are displayed in Table 5.

**Table 5: Duration of the In-service Teacher Training Workshops**

Duration	Frequency	Percentage
1-2 days	1	16.7
3-4 days	1	16.7
5-6 days	4	66.6
Total	6	100.0

Table 5 limits the distribution of the teacher's responses to the six teachers who have attended in-service teacher training workshops. Two (33.4%) of them said the in-service teacher training workshops they have attended lasted for at most four days. The table further indicates that 4 (66.6%) of the teachers have attended in-service teacher training workshops that lasted for 5-6 days.

The next issue regarding in-service teacher training was the content of the workshops. Table 6 shows the distribution of the topics that have been covered at the in-service teacher training workshops. These were the topics the six teachers have been exposed to at the workshops.

**Table 6: Topics Treated at In-service Teachers Training Workshops**

Workshop topics	Frequency	Percentage
Lesson planning	6	27.3
Lesson presentation	6	27.3
Classroom management	6	27.3
Testing & evaluation	4	18.1
Total		100.0

Table 6 shows that among the topics facilitated at the in-service teacher training workshops lesson planning and lesson presentation together constituted 54.6%. The remaining 45.4% consisted of classroom management and testing and evaluation. No topics in mathematics or mathematics related content areas have been facilitated at the in-service teachers training workshops.

The mathematics teachers' perception of the relevance of the in-service teacher training workshops they attended is displayed in Table 7.

**Table 7: Perceived Relevance of In-service Teachers Training Workshops**

Degree of relevance	Frequency	Percentage
Sometimes Relevant	1	16.7
Often Relevant	3	50.0
Always Relevant	2	33.3
Total	6	100.0

Table 7 shows that the majority of the mathematics teachers who attended in-service teachers training workshops (i.e. 83.3% of them) found them to be relevant. In fact, two teachers thought the in-service teacher training workshops were always relevant (to their needs).

Almost all 9 (90%) of the mathematics teachers in the study declare that in-service education and training (INSET) is vital for their professional development. INSET was provided for 6 of the 10 teachers teaching mathematics. Five (83.3%) of the 6 mathematics teachers for whom INSET was provided perceived INSET as being relevant to their needs. However the teachers perceive the provision of INSET to be inadequate. For example,



INSET was not provided for 4 (40%) of the 10 teachers teaching mathematics in the selected high schools in Nimba County. Also, no topics in mathematics or mathematics related content areas were included in the INSET programmes. Generally, the time allotted to INSET was also inadequate. For example, 5 (83.3%) of the teachers indicated that they have had INSET once an academic year. The duration of INSET the teachers have had varied. For instance one teacher has had in for 1-2 days; another one teacher has had it for 3-4 days, while 4 teachers have had it for 5-6 days.

Also, the same teachers of the same school have been the facilitators of INSET programmes during the four academic years (2004/05 – 2007/08). As a result, INSET activities became routine exercises, where these teachers facilitated the same topics repeatedly over the years. Additionally neither the relevant authorities of Nimba County School System nor the relevant authorities of the Ministry of Education of Liberia organised INSET for the mathematics teachers in selected schools in the county.

### **Analyses of Past Performance Results of Students on LSHSCE**

#### **Mathematics: 2004/05-2007/08**

The section looks at the students' data starting with students' grades in mathematics. The LSHSCE mathematics results are presented in grades to indicate the candidates' performance in the examination. The grades range from 1 to 9 with grades 1-8 interpreted generally as success and 9 considered as fail at the examination. Grades 1-3 are labeled excellent, 4-6 are rated honor and 7-8 are considered ordinary passes. In Liberia, the grades are referred to as "marks" so the words "grade" (as in a student had a grade 5 in the LSHSCE examination) and "marks" (as in the student scored 5 marks in the LSHSCE)

are used interchangeably in the discussion of students' performance in the LSHSCE mathematics. The students' grades in the examination from 2004/05 - 2007/08 are displayed in Table 8.

**Table 8: High School Students' Performance in Mathematics in the LSHSCE in the early Post War era**

Academic year	2004/05		2005/06	
Score	Frequency	Percent	Frequency	Percent
6	0	0.0	4	0.6
7	31	4.8	98	14.5
8	374	58.5	404	59.7
9	235	36.7	171	25.2
Total	640	100.0	677	100.0
Academic year	2006/07		2007/08	
6	0	0.0	5	0.7
7	96	12.3	144	20.4
8	583	74.9	532	75.5
9	100	12.8	24	3.4
Total	779	100.0	705	100.0

In Table 8, 31 (4.8%) of the students in the selected senior high schools in Nimba County who sat the LSHSCE mathematics in 2004/05, had grade 7 and 374 (58.5%) of them scored 8 marks. This means that 63.3% of the students who wrote the test in that year passed mathematics successfully.

In 2005/06 school year, 4(0.6%) of the students scored 6 marks and 98 (14.5%) scored 7. All together 506 (74.8%) of the students passed LSHSCE

mathematics in 2005/06. Table 8 further shows that 679 (87.1%) of the twelfth-grade students from the selected schools who sat the LSHSCE in 2006/07 passed mathematics. The 87.1% is made up of 12.3% who scored 7 marks, and 74.8% who scored 8 marks. Again, Table 8 indicates that 12.8% of the candidates in 2006/07 scored 9 marks or failed mathematics.

For the 2007/08 academic year 681 (96.6%) of the students of selected schools in Nimba County who wrote the LSHSCE passed mathematics. The breakdown of the above figure is as follows: 5 (0.7%) earned 6; 144 (20.4%) scored 7 marks; and 532 (78.2%) made 8 marks. This shows that 3.4% of the students failed the mathematics examination in the 2007/08 academic year.

Research Question Three: How well are high school students of the selected schools performing in mathematics in the LSHSCE?

It can be noted that the pass rates progressed from 2004/05 through 2005/06, 2006/07 and up to 2007/08. For example, in 2004/05 the percentage of twelfth-grade candidates in the selected schools who passed the LSHSCE mathematics was 63.3%. In 2005/06 there was an improvement in the pass rate to 74.8% an increase of 18.2%. Also in 2006/07 there was further improvement in the pass rate to 87.2% an increase of 16.5% over the previous year. The 2007/08 academic year also experienced an upward trend in the pass rate. In 2007/08 the pass rate rose to 96.6% indicating an increase of 10.8% in 2007/08. Besides the pass rate increasing in quantity, it also increased in quality. In 2004/05 for instance, 4.8% of the candidates scored 7 marks while the percentages were 14.5% in 2005/06, 12.3% in 2006/07, and 20.4% in 2007/08. In 2005/06, 0.6% of the students passed with honor. Similarly, in 2007/08, 0.7% of candidates passed mathematics with honor.

The pass rate increased over the four academic years. The improvement in the pass rate was however in terms of the quantity of ordinary pass scores and not necessarily in the quality of the scores. For example, in 2005/06 school year, only 4 (0.6%) of the students made a lower honor score of 6. This percentage (i.e. 0.6%) is far below 1% and therefore, cannot be said to be a significant gain in quality pass rate. Also in 2007/08, 5 (0.7%) of the candidates who wrote the LSHSCE made a lower honor score of 6. This, too, (i.e. 0.7%) is below 1%.

It can therefore be noted that the students in the selected high schools in Nimba County who sat the LSHSCE made ordinary passes in mathematics over the four school years (2004/05 – 2007/08). The students made ordinary passes by gaining scores which are extremely low in quality achievement. None of the candidates earned a middle honor score of 5, let alone the upper honor score of 4 or excellent scores of 3, 2, or 1.

Even though the students in the selected high schools in Nimba County have made some gains by increasing the pass rate in LSHSCE mathematics over the four academic years, the students did not improve on the quality of the scores. The students have not improved on the quality of the pass rate. They continue to make grades that are at the bottom of the pass continuum. It can be concluded, therefore, that students are not performing well in the Liberia Senior High School Certificate Examination mathematics in the selected schools in Nimba County. Pictorial diagrams of the trends in high school students' achievement in LSHSCE mathematics are given in Appendix A (p. 131). These histograms show the trends in the students' achievement in LSHSCE mathematics in the four consecutive school years more clearly.

The analyses presented involved the scores of past twelfth grade students in the LSHSCE mathematics (from 2004/05 to 2007/08), and the frequencies and percentages of these scores. The trends in students' achievement were also analysed. The next aspect of the analysis is to respond to Research Questions Four and to test each of the hypotheses that guided the study.

### **Influence of High School Mathematics Teachers' Characteristics on their Students' Achievement in LSHSCE Mathematics**

Since a major purpose of the study was to investigate the influence of high school mathematics teachers' characteristics on their students' mathematics achievement in LSHSCE, the data on achievement were further analysed using ANOVA to find out if the observed differences among the various categories of teacher characteristics were statistically significant.

Four hypotheses were drawn from Research Question Four. Each hypothesis has a corresponding null hypothesis. It is the null hypotheses which have been tested to address the research question. Each null hypothesis was tested at the significance level of  $\alpha = .05$ . For  $\alpha = .05$  or  $\alpha < .05$ , the null hypothesis was rejected. However for  $\alpha > .05$  the null hypothesis was accepted. Research Question Four is: What is the influence of high school mathematics teachers' characteristics (i.e. training status, area of specialism, type of academic qualification, and years of teaching experience) on their students' achievement in LSHSCE mathematics? The high school mathematics teacher's characteristics were investigated one by one and their corresponding research questions addressed using the appropriate statistical tests.

It was hypothesised that a high school mathematics teacher's training status influences their students' LSHSCE mathematics achievement. The corresponding null hypothesis (which was tested) is that 'high school mathematics teachers' training status has no influence on their students' achievement in LSHSCE mathematics'. Table 9 shows whether there was significant difference between high school mathematics teachers training status and students' achievement in LSHSCE mathematics in selected high schools in Nimba County early post war era.

**Table 9: Teacher Training Status and Student Achievement (One-Way ANOVA)**

Academic Year		SS	df	MS	F	Sig.
2004/05	B/G*	30.762	2	15.381	57.560	.001
	W/G**	170.213	637	.267		
	Total	200.975	639			
2005/06	B/G*	29.753	2	14.877	40.267	.012
	W/G**	249.006	674	.369		
	Total	278.759	676			
2006/07	B/G*	21.193	2	10.597	47.047	.003
	W/G**	174.786	776	.225		
	Total	195.979	778			
2007/08	B/G*	17.063	2	8.531	40.751	.011
	W/G**	146.966	702	.209		
	Total	164.028	704			

B/G\* = Between Groups , W/G\*\* = Within Groups.

The analysis of variance in Table 9 displays the training status of the mathematics teachers. The significance level for each academic year was less

than the alpha level of .05. This means there were significant differences among the high school mathematics teachers. These differences were reflected in the achievement of the students taught by particular category of mathematics teachers. For example, the students taught by highly trained teachers, or less trained teachers, or untrained teachers may perform differently on the LSHSCE mathematics. ANOVA did not show exactly where the differences were. A multiple-comparisons test (Freund, 1999) like Duncan multiple-range test (DMRT) enables one to make independent statements about differences among several means with a known level of confidence.

Hence the Duncan multiple-range test was employed to make thorough analyses of the students' performances relative to the mathematics teachers' training characteristics. Duncan multiple range tests were used to identify the differences. The categories of mathematics teachers' characteristics (e.g. highly trained, less trained and untrained) whose influence on students' mathematics achievement was not significantly different had the mean performance of the students in the same vertical block. For example, in 2004/05 academic year, the mean performance (8.572) of the students taught by the less trained mathematics teachers and the mean performance (8.687) of the students taught by the untrained teacher teaching mathematics appeared in Block 2 under the heading students' achievement level. Duncan multiple range test (DMRT) in Table 10 specified the training status of the mathematics teachers and the performance of the students they taught.

**Table 10: Mathematics Teacher Training Status and Students' Achievement (DMRT)**

Academic year	Status of Teachers	Student achievement level		
		1	2	3
2004/05	Highly Trained	8.135		
	Less Trained		8.572	
	Untrained		8.687	
	Sig.	1.000	.301	
2005/06	Highly Trained	7.873		
	Less Trained		8.261	
	Untrained			8.517
	Sig.	1.000	1.000	1.000
2006/07	Highly Trained	7.818		
	Untrained		8.139	
	Less trained		8.152	
	Sig.	1.000	.846	
2007/08	Highly Trained	7.673		
	Less Trained		7.947	
	Untrained			8.176
	Sig.	1.000	1.000	1.000

According to Table 10, in 2004/05 school year, students of the selected high schools in Nimba County who were taught by highly trained mathematics teachers performed better than students who were taught by both less trained teachers and untrained teachers. Table 10 also shows that students taught by



less trained teachers and the students taught by the untrained teachers performed statistically at the same level. There was no significant difference between the mean scores of the students who were taught by the two different groups of teachers (less trained teachers and untrained teachers). This implies that the difference in the achievement of the students who were taught by the two different groups of mathematics teachers was statistically insignificant and therefore negligible.

Table 10 again reveals that in 2005/06, 2006/07 and 2007/08 academic years those students who were taught by highly trained mathematics teachers performed better than the students who were taught by both the less trained teachers and the untrained teachers. On the whole the students who were taught by highly trained teachers performed outstandingly. Also, the students who were taught by the less trained teachers performed better than those students who were taught by the untrained teachers.

In Table 10 the training status of the mathematics teachers and the achievement of the students in the LSHSCE mathematics show that mathematics teachers' training status has positive influence on students' achievement in mathematics. For example, the students taught by highly trained teachers performed better than the students taught by less trained teachers. In the same way students taught by the less trained teachers generally performed better than students taught by the untrained teachers. Therefore, the Table 10 shows that the highly trained teachers had more positive influence on the mathematics achievement results of the students they taught compared with the achievement results of the students taught by both the less trained teachers and the untrained mathematics teachers. It can be concluded,

therefore, that the training status of the high school mathematics teachers positively influences the students' achievement in LSHSCE mathematics.

It was hypothesised that high school mathematics teachers' specialism in the subject influences their students' LSHSCE mathematics achievement. The corresponding null hypothesis (which was tested) is that 'high school mathematics teachers' specialisation in the subject does not influence their student's achievement in LSHSCE mathematics.'

Table 11 shows the data for the investigation of the null hypothesis.

**Table 11: Specialisation of the Mathematics Teachers (One Way ANOVA)**

Academic Year		SS	df	MS	F	Sig.
2004/05	B/G*	5.373	2	2.686	8.748	.010
	W/G**	195.602	637	.307		
	Total	200.975	639			
2005/06	B/G*	56.994	2	28.497	86.610	.004
	W/G**	221.765	674	.329		
	Total	278.759	676			
2006/07	B/G*	1.799	2	.900	3.595	.028
	W/G**	194.180	776	.250		
	Total	195.979	778			
2007/08	B/G*	5.035	2	2.518	11.116	.013
	W/G**	158.993	702	.226		
	Total	164.028	704			

B/G\* = Between Groups, W/G\*\* = Within Groups

There were three groups of teachers in the study: those whose specialisation is a mathematic related subject (science degree: physics or chemistry); those whose specialisation is a mathematics combined with other subjects (e.g. mathematics /physics degree); and those whose specialisation is not a mathematic related subject (e.g. Nursing). Table 11 shows significant

differences in mathematics teachers' specialisation and the achievement of the students they taught. For instance, in 2004/05, 2005/06, 2006/07 and 2007/08, the respective significance levels were .010, .004, .028, and .013.

Each level of significance is less than .05. The significance level between mathematics teachers' specialisation and students' learning outcomes in mathematics being less than the alpha value of .05 indicates that there were significant differences in the performance of students who were taught by teachers in different categories of subject specialisation. The results of the analysis of variance (ANOVA) in Table 11 did not show explicitly which teachers' subject area specialty influences students' achievement the more.

A further investigation was conducted, therefore, to find out the extent of students' performance in mathematics relative to the various categories of teachers' subject area specialisation. The Duncan multiple range test was carried out in the investigation. The Duncan multiple range test gave details of the mathematics teachers' subject area specialisation and its effect on the students' performance in the LSHSCE mathematics for each school year.

Table 12 presents the results of the Duncan multiple range test for the mathematics teacher's subject area specialty and students' achievement in mathematics. Table 12 shows that students who were taught by teachers with major in either mathematics or mathematics related disciplines like physics and chemistry performed better than students who were taught by teachers with no mathematics or mathematics related discipline background. For example, in 2004/05 academic year, the difference between the mean performance scores of students taught by teachers with mathematics subject related background and the students taught by teachers with no mathematics

subject or mathematics related subject background was found to be -0.487 (that is 8.200-8.687).

**Table 12: Mathematics Teacher’s Specialisation and Students’ Achievement in Mathematics (DMRT)**

Academic Year	Teacher Specialisation	Student achievement level		
		1	2	3
2004/05	Math Related	8.200		
	Math + Others	8.355		
	Non-Math Related		8.687	
	Sig.	.195	1.000	
2005/06	Math Related	7.449		
	Math + Others		8.204	
	Non-Math Related			8.517
	Sig.	1.000	1.000	1.000
2006/07	Math Related	7.923		
	Math + Others	8.015	8.015	
	Non-Math Related		8.139	
	Sig.	.207	.089	
2007/08	Math + Others	7.783		
	Math Related	7.837		
	Non-Math Related		8.176	
	Sig.	.470	1.000	

Also the difference between the mean scores of the students taught by the mathematics teachers with major in either mathematics combined with

other subjects or in mathematics related subjects and students taught by teachers with no mathematics or mathematics subject background was calculated and found to be -0.332 (that is 8.355-8.687). Similarly, in 2005/06 academic year, the difference between the mean scores of the students taught by the teachers with major in mathematics related subjects and the students taught by the teachers with no mathematics background or mathematics related subject background was -1.018 (i.e. 7.499 – 8.517). Again in 2005/06 school year, the difference between the mean scores of the students taught by the teachers with major in mathematics and the students taught by teachers with major fields other than mathematics or mathematics related subject was found to be – 0.313 (i.e. 8.204 – 8.517). These outcomes indicate that the students taught by teachers with mathematics subject background or mathematics subject related background performed better in the LSHSCE Mathematics than the students taught by the teachers with no mathematics or mathematics subject related background. The effects of specialisation of these mathematics teachers on the achievement of their students in the LSHSCE mathematics were also the same for the other two academic years (2006/07 and 2007/08). It is therefore concluded that the area of specialisation of a high school mathematics teacher influences his or her students' achievement in mathematics.

It was hypothesised that high school mathematics teachers' qualification in the subject influences their students' LSHSCE mathematics achievement. The corresponding null hypothesis (which was tested) is that the 'high school mathematics teachers' qualification in the subject does not influence their students' LSHSCE mathematics achievement'.

An investigation was conducted to determine the effect of a high school mathematics teacher's qualification on his or her students' learning outcomes in mathematics. The results of the investigation are organised in Table 13.

**Table 13: Mathematics Teachers' Qualification and Students' Achievement in Mathematics (One Way ANOVA)**

Academic Year		SS	df	MS	F	Sig.
2004/05	B/G*	30.898	3	10.299	38.514	.021
	W/G**	170.077	636	.267		
	Total	200.975	639			
2005/06	B/G*	32.184	3	10.728	29.281	.003
	W/G**	246.575	673	.366		
	Total	278.759	676			
2006/07	B/G*	24.014	3	8.005	36.076	.010
	W/G**	171.965	775	.222		
	Total	195.979	778			
2007/08	B/G*	17.363	3	5.788	27.662	.011
	W/G**	146.666	701	.209		
	Total	164.028	704			

B/G\* = Between Groups, W/G\*\* = Within Groups

Table 13 shows the significance level between teacher's qualification and students' performance in mathematics for each academic year to be lower than an alpha value of .05. This means that there were significant differences between mathematics teacher qualification and students' achievement in mathematics. The Duncan multiple range tests gave details about specific

teacher's qualification that produced students' achievement results in mathematics. These details are given in Table 14.

**Table 14: Mathematics Teacher's Qualification and Students' Achievement in Mathematics (DMRT)**

School Year	Teacher Qualification	Student achievement level		
		1	2	3
2004/05	B. Sc.	8.135		
	C-Certificate		8.542	
	B-Certificate		8.590	
	College Student		8.687	
	Sig.	1.000	.194	
2005/06	B. Sc.	7.873		
	B-Certificate		8.195	
	C-Certificate		8.369	8.369
	College Student			8.517
	Sig.	1.000	.700	.123
2006/07	B. Sc.	7.818		
	C-Certificate		8.031	
	College Student		8.139	8.139
	B-Certificate			8.211
	Sig.	1.000	.094	.267
2007/08	B. Sc.	7.673		
	B-Certificate		7.920	
	C-Certificate		7.984	
	College Student			8.176
	Sig.	1.000	.356	1.000

Table 14 displays the qualifications of the mathematics teachers and students' achievement in mathematics in selected high schools in Nimba County. The table indicates that students who were taught by teachers with Bachelor of Science Degree (B.Sc.) performed better on the LSHSCE

mathematics administered in the four school years: 2004/05, 2005/06, 2006/07 and 2007/08. For instance, in 2004/05 academic year the difference between the mean performance of the students taught by the mathematics teachers with B.Sc. degree and the mean performance of the students taught by mathematics teachers with B-Certificate was -0.455 (i.e. 8.135-8.590). Also, in 2005/06 the difference between the mean performance of the students taught by the mathematics teacher who had B.Sc. and the mean performance of those students taught by the mathematics teachers with B-Certificates was -0.322 (i.e. 7.873-8.195). Similarly, in 2006/07 the difference between the mean performance of students taught by teachers with B.Sc. and the mean performance of the students taught by the mathematics teachers with B-Certificates was given as -0.393 (i.e. 7.818-8.211). Finally in 2007/08 too, the mean performance of the students taught by the mathematics teachers who had B.Sc. degrees and the mean performance of students taught by teachers with B-Certificates differed by -0.247 (i.e. 7.673-7.920).

For the four school years it was found that the senior high school mathematics teachers with the highest academic qualifications had the most positive influence on the mathematics achievement results in LSHSCE mathematics of the senior high school students they taught in selected schools in Nimba County. In other words, senior high school students who were taught by the mathematics teachers with Bachelor of Science (B.Sc.) Degrees outperformed those high school students who were taught by the mathematics teachers who had lower type of academic qualifications like B – Certificate, and C – Certificate. It can therefore be concluded that the type of academic qualification of a high school mathematics teacher influences his or her students' achievement in mathematics.



It was hypothesised that high school mathematics teachers' experience in teaching the subject influences their students' LSHSCE mathematics achievement. The corresponding null hypothesis (which was tested) is that 'high school mathematics teachers' experience in teaching the subject does not influence their students' LSHSCE mathematics achievement'. An investigation was carried out to determine the effect of high school mathematics teacher's years of teaching experience on his or her students' achievement in mathematics. The outcomes of the investigation are organised in Table 15.

**Table 15: Mathematics Teacher's Years of Teaching Experience and Students' Achievement in Mathematics (One Way ANOVA)**

Academic Year		SS	df	MS	F	Sig.
2004/05	B/G*	39.512	5	7.902	31.029	.015
	W/G**	161.463	634	.255		
	Total	200.975	639			
2005/06	B/G*	52.274	5	10.455	30.974	.006
	W/G**	226.485	671	.338		
	Total	278.759	676			
2006/07	B/G*	46.893	5	9.379	48.628	.008
	W/G**	149.086	773	.193		
	Total	195.979	778			
2007/08	B/G*	72.501	5	14.500	110.739	.013
	W/G**	91.527	699	.131		
	Total	164.028	704			

B/G\* = Between Groups, W/G\*\* = Within Groups

Table 15 presents the results of the analysis of variance run for all the four academic years under discussion. Table 15 shows significant differences in the high school mathematics teachers' years of teaching experience and the

achievement of the high school students in LSHSCE mathematics over the four consecutive academic years. These differences are indicated in the significant level in the table. It is shown that the significance level for each year was lower than the alpha value of .05. The significance level for each academic year being less than  $\alpha = .05$  indicates that significant differences exist between the high school mathematics teachers' years of teaching experience and the achievement in mathematics of the high school students those mathematics teachers taught.

The analysis of variance (ANOVA) only showed that differences exist between the years of teaching experience of the mathematics teachers and the extent of performance of the students in mathematics. ANOVA, however, did not indicate specifically which years of teaching experience produced specific achievement results of students. For example, ANOVA could not indicate specifically which years of teaching experience produced the highest achievement results. Also ANOVA could not show which years of teaching experience yielded the lowest performance results. There was a need, then, to study further which years of teaching experience produced either the highest students' mathematics achievement results or the least students' mathematics achievement results.

Therefore, to investigate further, the Duncan multiple-range test was employed to make thorough analyses of the high school mathematics teachers' years of teaching experience and their effects on high school students' learning outcomes in mathematics for each of four consecutive academic years, as before. The outcomes of the investigation for academic years 2004/05 and 2005/06 are given in Table 16.

**Table 16: Mathematics Teacher’s Years of Teaching Experience and Students’ Achievement in Mathematics (DMRT)**

School Year	Teaching Experience	Student achievement level			
		1	2	3	4
2004/05	10	7.406			
	5		8.050		
	9		8.230	8.230	
	1			8.338	
	3				8.563
	14				8.569
	Sig.	1.000	.073	.282	.958
2005/06	10	7.849			
	2	7.859			
	6		8.186		
	15		8.228	8.228	
	4			8.396	
	11				8.697
	Sig.	.917	.654	.078	1.000

Table 16 gives the years of teaching experience of the mathematics teachers and the achievement of the students in 2004/05 and 2005/06 school years. For example, in 2004/05 academic year, the students in the selected schools who were taught by the mathematics teachers with ten years of teaching experience were the best performing students. The performance of the students taught by the teachers with five years of teaching experience and the students taught by the teachers with nine years of teaching experience was statistically the same. Similarly, there was no significant difference between the mean performance of the students taught by beginning teachers with one year of teaching experience and the students taught by teachers with nine years

experience. The worst performing students were those taught by the teachers with either three years or fourteen years of teaching experience.

In 2005/06 the students taught by the teachers with either ten or two years of experience were the highest achieving students in mathematics. There was no significant difference between the achievement of the students taught by the teachers with six or fifteen year's expertise in teaching. Also, the performance of the students taught by the teachers with fifteen or four years of teaching experience was not significantly different. The least performing students in 2005/06 academic year were those taught by the teachers with eleven years of experience.

As stated earlier, for 2004/05 and 2005/06 school years, the analysis of variance (ANOVA) in Table 15 showed that there were differences between the mathematics teachers' years of teaching experience and the performance of the students they taught. Similarly, for 2006/07 and 2007/08 academic years, the ANOVA also showed that there were differences between the mathematics teachers' years of teaching experience and the learning outcomes of the students in mathematics. Here, too, ANOVA could not show exactly which years of teachers' teaching experience actually produced a particular achievement result of students in mathematics.

An investigation to find which years of teachers' teaching experience produced students' achievement gains in mathematics, therefore, was conducted using Duncan multiple range test. The results of the investigations are given in Table 17.

The years of teaching experience of the mathematics teachers and the achievement of the students in 2006/07 and 2007/08 are provided in Table 17.

**Table 17: Mathematics Teacher’s Years of Teaching Experience and Students’ Achievement in Mathematics (DMRT)**

School Year	Teaching Experience	Student achievement level		
		1	2	3
2006/07	11	7.405		
	3		8.038	
	12		8.044	
	5		8.058	
	7		8.132	
	16			8.272
	Sig.	1.000	.204	1.000
2007/08	12	7.022		
	4		7.805	
	8		7.891	
	13			8.015
	6			8.024
	17			8.058
	Sig.	1.000	.129	.481

Table 17 reveals that in 2006/07 academic year the students who were taught by the mathematics teachers with eleven years of teaching experience performed the best while the students who were taught by the teachers with sixteen years experience performed the least. Table 17 further reveals that there were no significant differences in the performances of the students who were taught by the teachers with three, twelve, five and seven years of teaching experience. Also, Table 17 shows that in 2007/08 school year the mathematics teachers with twelve years of teaching experience most positively influenced the learning outcomes of the students in the LSHSCE mathematics. The four or eight years experienced teachers had statistically the same

achievement effects on the students they taught. Finally, the students taught by the teachers with thirteen, six or seventeen years experience performed the least.

The discussion so far shows that there were significant differences between mathematics teachers' years of teaching experiences and the achievement of students in LSHSCE mathematics. However the effects of experience on achievement were not linear or uniform. Experience effects on performance did not follow uniform upward or downward trends. For example, if in 2004/05 school year experience had followed the pattern 1, 3, 5, 9, 10 and 14, and in 2005/06 experience had again shown effects on performance in the order 2, 4, 6, 10, 11, 15 and so on to 2007/08 then conclusion would have been that experience yielded uniformed effects on students' performance. But this was not the case. In some instances the students who were taught by more experienced teachers performed poorly than the students who were taught by less experienced teachers. In other instances too, the students who were taught by more experienced teachers performed outstandingly than the students who were taught by teachers with lesser experience. This observation requires further investigation to establish the causes of the non-linear patterns.

## **DISCUSSION**

This section provides the summary of the results gathered from the study and discusses them in relation to the research questions. There were four key research questions stated as follow:

1. Do high school students perceive the teaching style of their mathematics teachers as 'teacher-centred, student-centred, or both?'

2. How do the mathematics teachers perceive the provision of INSET in Nimba County post war era?
3. How well are high school students performing in mathematics in the LSHSCE?
4. What is the influence of high school mathematics teachers' characteristics (i.e. training status, area of specialisation, type of academic qualification, and years of teaching experience) on their students' mathematics achievement in LSHSCE?

The discussions of results were organised under these four key research questions. The fourth research question generated four sub-research questions. The result of every research question is discussed herein this section. The discussion of results follows a chronological order, starting with the first key research question.

1. As many as 176 (62.8%) of the twelfth grade students in the selected high schools in Nimba County perceive the teaching style of the mathematics teachers as being good practice as it promotes student-centred approaches.

For example, majority of the teachers, that is 240 (85.7%) of them, encourage the students to ask questions in the mathematics classes. It has been found that having students to communicate freely in the classrooms improve their performance. For example, the National Council of Teachers of Mathematics (NCTM, 2000) observe that students who have opportunities, encouragement, and support for speaking, writing, reading, and listening in mathematics classes reap dual benefits: they communicate to learn mathematics, and they learn to communicate mathematically.

On the other hand, 58 (20.6%) of the students perceive the mathematics teachers' teaching style as not good practice as it encourages teacher-centred approaches. Generally the students view the mathematics teachers' teaching style as containing both student-centred and teacher-centred approaches. It can be noted in Table 1 that 157 (56.1%) of the students argue that the mathematics teachers seldom or never had them do mathematics in small activity groups. Teaching should be dynamic and supported by using various teaching styles instead of applying just one technique. Vygotsky (as cited in Santrock, 2006) however observes that knowing can best be advanced through interaction with others in cooperative activities. He further declares that for desirable achievement results, students should be challenged to also do mathematics in small activity groups rather than just engaging them passively in the traditional, talk-chalk methods. Vygotsky (as cited in Capel, Leask, & Turner, 2005) asserts that what a child can do today in cooperation, tomorrow he will be able to do on his own. No one teaching method is the best approach. The importance of adopting and using a variety of teaching approaches has been acknowledged by other educators. Abdullai (n.d.) for example, has observed that "We seek instructional methods because of the knowledge explosion which has forced educators to seek instructional methods that will make students to become involved in the learning process rather than simply memorising all the facts" (pp. 30 – 31).

According to Kochhar (2004) all methods under certain conditions will result in poor teaching. He named these conditions as the nature of the subject, the ability of the teacher, the status of the student, and the availability of teaching aids. Kochhar (2004) further argues that teaching which influences



students' achievement adapts methods to purpose, content, and student status and teacher ability and at the same time it permits and encourages the use of variety of methods. It however does not seek perfection in any single method. Farrant (2004) declares that teachers must choose the method they think will serve their purpose best. He however cautions that teachers should bear in mind that one method, which may be delightful and stimulating if used from time to time, can become wearisome if used frequently.

Ellis (1992) declares that effective teaching supports the use of a variety of teaching strategies for two reasons:

- Students respond differently to various ways of teaching. Some students learn effectively through silent reading, others do not. Some students benefit from direct instruction, others seem to learn more from inquiry methods.
- Students gain from variety in instruction: discussions, hands-on projects, games, demonstrations, and other strategies.

It is shown that more than 50.0% of the students argue that the mathematics teachers hardly ever or never use a variety of teaching-learning aids to teach them mathematics. Reys (as cited in Post, 1992) declares that unless conceptual errors are corrected, students will continue to struggle with mathematical topics. The mathematics teacher must learn to use manipulative aids to help the students achieve in mathematics. An effective use of manipulative teaching aids helps to concretise students' learning of abstract concepts. Also, WAEC (2008) asserts that the teaching of mathematics be made practical with the help of visual aids from the Elementary level to relate to the pupils' environment.

The students mentioned that the teacher marked their papers and gave them feedback on their performance on regular bases. In addition to providing regular feedback to the students, the mathematics teacher also reinforced their learning of mathematics. For example, he reviewed with them homework, quizzes and tests after marking and returning the papers to the students (See Table 1). Nitko (2001) declares that the teacher should provide enough feedback to foster students' conceptual knowledge and improve their performance. Nitko (2001) further says that the teacher should make corrections on students' mistakes before he goes to new instruction.

The teacher makes connections between the applications of mathematics to many other subjects like physics, geography, chemistry and biology. Also the mathematics teacher relates new mathematics lessons to past mathematics lessons. The teacher also uses simple, concise words to teach and to explain mathematics concepts to his students. Additionally the teacher uses extra time to help his students improve their mathematical skills. The core issue of teaching should be to help students learn lessons the teacher tends to facilitate. The next discussion focuses on the mathematics teachers' perception of the provision of in-service education and training in Nimba County post war era.

2. Tables 2, 3, 4, 5, 6, and 7 were used to address the research question pertaining to the mathematics teachers' view about the provision of in-service education and training (INSET) in Nimba County post war era.

The mathematics teachers view INSET as good for their professional development. The teachers, however, argue that the provision of INSET in selected schools in Nimba County post war era is inadequate. The six

mathematics teachers, for whom INSET has been provided, for example, argue that no mathematics contents have been facilitated at any of the INSET programmes. INSET should not be arbitrarily provided just for the sake of providing it. INSET must focus certain key issues that must be remedied in order to improve education quality.

Adentwi (2002) asserts that curriculum-related INSET introduces teachers to innovations taking place in curriculum of schools or to help implement education reforms. Liberia has just recovered from crisis. Curriculum has been revised for all grade levels. New contents may have been added to the curriculum of every core subject. INSET programmes could help to enlighten the teachers about effective implementation of these new curriculum contents. INSET programmes should not be for routine activities rather they should be organized for improving the education system. For example, Adentwi (2002) observes that INSET programmes help to correct deficiencies or to expand upon existing proficiencies of teachers. Also, Smith (as cited in Adentwi, 2005) states some goals of INSET as follow:

1. To remedy the teacher deficiencies arising out of defects in his initial teacher training preparation,
2. To advance the teacher's skills and pedagogical knowledge required for new teaching roles, and
3. To advance and update the teacher's knowledge of subject-matter and new trends in curriculum development.

Teachers of mathematics (and those of other core subjects) must be given constant in-service education and training opportunities to keep them abreast of development taking place in the education front. No one can give

away what he or she does not have. So for the mathematics teachers to be able to effectively deliver the mathematics contents to their students, the teachers must acquire adequate knowledge of the subject as well as the subject-content delivery strategies. One way for the teachers to gain such subject-content delivery techniques is through their active participation in INSET activities. Many of the mathematics teachers in selected schools in Nimba County have not had the opportunity to participate in INSET programmes. For example, INSET programmes have not been organized for four of the ten mathematics teachers in the study.

Darling-Hammond (1999) observes that one way to help students gain quality education is to have the teachers improve on their knowledge and skills through staff development like INSET programmes. The effect of in-service teacher training on student's achievement cannot be exaggerated. In-service teacher training workshops are integral components of teacher preparation and professional development programmes. Adentwi (2002) points out that in-service education and training programmes are usually supplementary to the initial training the teacher received at college. In-service teacher workshops keep the teachers awake and abreast of the new development in the subject matter they are to facilitate. The importance of in-service teacher workshops as an essential supplement to initial teacher training and professional development programmes was acknowledged by 9(90%) of the teachers teaching mathematics. In fact, 5(83.3%) of the teachers for whom in-service teacher workshops were planned and executed considered it to be relevant. At the same time, 2(33.3%) found in-service teacher workshops to be always relevant. Indeed, no amount of time spent in college or university will

complete the preparation of the teacher for his or her classroom tasks. Teachers must continue with their education after their graduation through in-service education and training. In-service teacher workshops were organised and conducted to help upgrade the skills and knowledge of participants. Instead of having teacher in-service workshops that are general, there is need to plan and execute content-specific workshops for mathematics teachers. Harris and Sass (2007) observed that content-focused teacher professional development was positively correlated with productivity in middle and high school mathematics. Updating the skills and knowledge of the mathematics teachers would serve as a basis for improving the learning outcomes of the students they teach.

There is an explosion of knowledge taking place worldwide each day. Also, the skills and knowledge the teacher has gained from initial training may start to wear out with time. Therefore there is need for the mathematics teachers to upgrade their skills and knowledge to match with education development and reforms. Jackson (1982) asserts that one way to salvage the teacher component of the Liberian educational system is to provide opportunities for upgrading and continuous professional growth of the teachers. Staff development or in-service training can offer the teacher the opportunity to upgrade the skills and knowledge in a subject area.

The Government of Liberia and other stakeholders currently keep a low profile in sponsoring and conducting in-service teacher workshops. It was indicated by 60% of the teachers teaching mathematics that they attended in-service teacher workshops orchestrated and sponsored by individual schools. In-service teacher workshops are integral components of initial training

programmes. As mentioned earlier in this study, Farrant (2004) noted that in-service education and training should be a lifelong process in which the teacher is continually learning and adapting to novel challenges of his or her job. So the failure of the Government (or designated educational authorities to organise and conduct in-service teacher workshops) is like ignoring the positive effects of the workshops on students' achievement.

In-service teacher workshops must be ongoing in the schools. In-service teacher workshops are the next important facets in the initial teacher training. Downplaying the significance of in-service teacher workshops would imply ignoring teacher continuous professional development. Ignoring updating teacher skills and professional development through in-service workshops would also imply neglecting students' achievement, for the aim of improving teachers' skills and professional development is to help improve students' learning outcomes.

3. The focus of the next aspect of the discussion centers on how well the high school students are performing in mathematics in the LSHSCE. The students' pass rate in the Liberia Senior High School Certificate Examination mathematics has improved gradually since 2004/05 to 2007/08 school years. The quality of the scores, however, remains woefully poor. So, there is a need to reverse the low performance of students in mathematics.

The poor performance of high school graduates in the LSHSCE mathematics has serious implications for the development of Liberia. For instance, the pool of qualified personnel must be drawn from the high school graduates to take up various positions including mathematics teachers, mathematics educators, engineers, and so forth in Nimba County (and in

Liberia). These high school graduates must therefore have solid mathematics (and mathematics related) subject background in order to facilitate teaching and learning of mathematics should they become mathematics teachers. With a sound content-based knowledge in mathematics, the teachers could facilitate learning of the students. Ball, Hill, and Bass (2005), for example, observe that a good facilitator of any subject should have sound content-based knowledge in that subject. In order to improve the students' performance in mathematics, the mathematics teachers must teach them in ways that promote deep understanding of the subject. The students must be taught to demonstrate conceptual understanding of mathematics and to earn scores that are better than ordinary passes they are having. The mathematics teachers must engage the students in ways that encourage learning mathematics by doing mathematics. It has been shown that mathematics is learned by doing mathematics (Oakes & Lipton, 2003; Gartrell, 1998).

4. The training status of high school mathematics teachers has positive effect on the performance of high school students in LSHSCE mathematics. Twelfth Grade students taught by highly trained mathematics teachers performed better than the Twelfth Grade students taught by both less trained and untrained mathematics teachers. This is not surprising because teacher training is about guiding teachers to enable them to empower learners and make them succeed in their learning. Indeed, a number of studies have shown that if a teacher is well trained, then he or she can help learners better. One of these studies (Hurd, 2007) even suggests that the number of teacher trainees in a school-based teacher training programme improves students' achievement. As mentioned in Chapter 2, Bressoux (1996), using a quasi-experimental design,

found that teacher training increases student performance. This is one reason why the mathematics teachers must be adequately prepared through formal teacher training to acquire these needed skills. The finding of this study regarding training therefore lends weight to the amount of resources that the government of Liberia is putting into teacher training in Liberia. The number of mathematics teachers in the senior high schools in Nimba County was inadequate. Here too, the researcher is not surprised because of the money involved in training teachers. Some of the teachers trained in Liberia do not pay fees and this means that the government has to subsidise teacher training. This coupled with the fact that not many people have the desire to train to become mathematics teacher and even those who have a bachelor degree in mathematics may want to work in other sectors. Considering the opportunities that exist outside education for mathematics teachers, the government of Liberia will have to step up the drive for enticing more mathematics graduates to go into teaching.

5. Regarding teachers' specialist areas, it was found that teachers of other academic disciplines were used as mathematics teachers due to the shortage of qualified mathematics teachers. In this study, as many as 5(50%) of the teachers who were not trained or prepared to teach senior high school mathematics were found teaching Twelfth Grade classes. Of the 50%, 1(20%) was a nursing student. The other 4(80%) were general science and mathematics teachers. These patterns are the legacy of the low enrolments in mathematics in pre-service training programmes. The number of graduates of the Teachers College of the University of Liberia (especially mathematics or mathematics related subject majors) is woefully inadequate. Also the number of entrants of mathematics or mathematics related discipline majors into the



Teachers College is also inadequate. There must be targeted scholarships programmes in the Ministry of Education of Liberia as part of its teacher education reform to correct the problem.

Specialisation of mathematics teachers has positive impact on the achievement of the Twelfth Grade students in LSHSCE mathematics in selected schools. Teachers of mathematics who were specialised in mathematics had in-depth understanding of the subject matter. As such they would have explained and demonstrated clearly to the students' ways to solve problems. With a sound content-based knowledge in mathematics, the teachers could facilitate the learning of the students. Ball, Hill, and Bass (2005) observe that to be a good facilitator of any subject, one should have a sound content-based knowledge in that subject. Also, the National Study Council (2001) found that students who were taught by teachers with specialty in mathematics performed better on the NAEP mathematics tests than the students who were taught by teachers who were specialised in other disciplines. Mathematics is a core subject and a gateway to a lot of opportunities (e.g. passing LSHSCE). The county educational authorities need to collaborate with the government of Liberia. This could be done through the Ministry of Education to recruit more high school graduates with aptitude in mathematics. These high school graduates must express their desire of becoming career mathematics teachers before they can be recruited and awarded the scholarships to study. These high school graduates would then be trained at bachelor's degree level to empower them teach mathematics at high schools upon their graduation.

6. As many as 50% of the teachers teaching Twelfth Grade mathematics were unqualified and others were teaching a subject which is not their specialist

area. Specifically, 1 (10%) of the teachers was a nursing school student teaching high school mathematics. Also, 2 (20%) of the teachers were prepared to teach Ninth grade down to Seventh grade. The remaining 2 (20%) were only qualified to teach in primary schools. Yet, according to the Ministry of Education of Liberia (MOE, 2000), the minimum qualification for a teacher to teach senior high school is a bachelor's degree. This means that teachers of mathematics of the Twelfth Grade must have at least a bachelor's degree in mathematics. Employing untrained teachers to teach Twelfth Grade mathematics has serious implications for the future development of Liberia vis-à-vis students' learning. A teacher who is not qualified to teach at a particular grade level (e.g. Twelfth Grade) may not be teaching the subject to the students for their understanding. To teach for understanding, teachers must thoroughly understand the subject matter so that they can present it in a challenging, clear, and concise manner (National Commission on Teaching and America's Future, 1996). There may be qualified mathematics teachers who were not motivated and had not returned to the classroom since the crisis ended. Those qualified mathematics teachers need to be encouraged by the relevant county education authorities to take reassignment in the schools. Teachers who are qualified will have deeper understanding of the subject they teach than teachers who are not qualified.

There are many studies which show that possessing a major or minor in mathematics or mathematics related subjects has positive effect on students' achievement in mathematics. For example, National Research Council (NRC, 2001) found that students who were taught by teachers with certificates in mathematics out performed on the NAEP Mathematics tests, than students

whose teachers had their certificates in other fields. Also, California Department of Education (1997) and National Council of Teachers of Mathematics (2000) emphasised that understanding mathematics requires knowing the key concepts, themes and relationships. For example, the mathematics teachers must be able to see clearly the relationships between diverse content areas of mathematics. They should be able to make both interdisciplinary connections in teaching mathematics. To be able to make such connections, the teachers must have a major or minor in mathematics. The positive effects of the teachers having a major or a minor in mathematics or mathematics related subjects on students achievement was seen throughout the four academic years covered in the study.

County education authorities and the Ministry of Education should motivate more competent high school graduates (by awarding them full local scholarships) to study mathematics education at bachelor's degree level to prepare them teach high school mathematics. Teachers with a major or a minor in mathematics or mathematics related subjects would be able to represent and explain concepts about subject matter and demonstrate conceptual understanding (Mosenthal & Ball, 1992). As indicated in Chapter 2, students taught by teachers with certificates in mathematics outperformed on the NAEP Mathematics tests, than students taught by teachers with certificates in different fields. This calls for the training of more teachers by the Ministry of Education of Liberia in mathematics or mathematics related subjects.

As mentioned above, the qualification of the high school mathematics teachers had positive effect on students' performance in LSHSCE

mathematics. Mathematics teacher's qualification and students' achievement were positively correlated. An increase in one also produced an increase in the other one and vice versa. For example it was found that students taught by teachers with a bachelor's degree performed better on LSHSCE mathematics than students taught by teachers with qualifications lower than a bachelor's degree. This finding is in line with the finding of the National Study Council (2001) that students who were taught by teachers with certificates in mathematics performed better on the NAEP Mathematics tests, than students who were taught by teachers whose certificates were in other fields. The implication of this for Central Government and educators in Liberia is that the educational policy that high school mathematics teachers should have an undergraduate degree in mathematics or mathematics related subjects should be upheld and implemented fully. Implementing this policy requires awarding study opportunities to potential high school mathematics teachers (who are teaching but are not qualified) to upgrade themselves. It also means awarding full scholarships (stipends for lodging, feeding, transportation, books, etc) to potential high school graduates with outstanding performance in mathematics and mathematics related subjects who are determined and desirous of pursuing teaching as a career.

7. Many of the high school mathematics teachers were found to be inexperienced. The more experienced mathematics teachers may have deserted the teaching field for a more lucrative and payable job. Other experienced high school mathematics teachers may have died in the Liberia crisis. With low salaries paid to teachers in Liberia other experienced mathematics teachers may have felt reluctant to consider reassignment in the classroom. Most of the

new and inexperienced teachers joined the teaching field immediately after the end of the Liberia crises. Brophy (2004) argues that the absence of pedagogical awareness of the students, inexperienced teachers simply rely on textbook materials which, of course, contain no information about particular pedagogical needs of the students in the classroom. The implication of the statement above is that teachers must acquire the necessary professional teaching skills in addition to the subject-content knowledge. With the requisite pedagogical content knowledge of the mathematics teachers, they should be able to exert the rightful amount of stress on the students to extend their understanding reasonably beyond the current level. There were (and there still are) acute shortages of qualified mathematics teachers in the high schools. The inexperienced mathematics teachers who were willing to teach took assignment in the classroom. Some of the more experienced teachers pursued further studies in other disciplines in colleges or universities in the country. Considering all that had been enumerated here, Government needs to take appropriate steps to remedy the situation. One way of doing this is to raise salaries for teachers. Government also needs to implement the conference recommendation h (p.44) (MOE, 2000), Education Sector Review (2000): Vol. II, Liberia Education Sector Master Plan (2000-2010). The recommendation is that 80% of the in-service teacher training scholarships be allocated to mathematics, science and English Language teachers.

Teacher years of experience have positive effect on students' achievement in mathematics. However, the effect is not linear. Murnane and Phillips (1981) for example, have found that the relationship between student learning and teachers' years of experience is not an entirely linear one. This result paralleled the result found in this study. Tables 16 and 17 show that

effect. However Rosenholtz (1986) argues that as beginning teachers teach the same subject over a certain period of time; they may begin to gain ideas of teaching that would make them become effective teachers. The idea of teaching is to help students learn, remember and apply what they are supposed to learn.

Oakes and Lipton (2003), and Lindquist (1990) declare that mathematics is learned by doing mathematics. Other methods like project and cooperative teaching methods must be adopted and utilised by the mathematics teachers to help the students learn mathematics. As stated earlier, Bruner (cited in Krajcik, Czerniak, & Berger, 2003) observe that the more active and concrete the learning of students, the more they retain what they are taught. Teachers of mathematics should make abstraction in mathematics concrete by relating mathematics to real-life situations. Teachers of mathematics should use a mixture of teaching strategies in conducting mathematics classes and lessons because different students have different learning styles. Teaching mathematics must be adapted to the learning styles of the different students in the classrooms. Shulman (1987) points out that teachers should have a deep understanding of the subject so they can present the discipline in multiple ways: clothed in activities and emotion, in metaphors and exercises, and in examples and demonstrations, so that it can be grasped by students. There is no one good way of teaching mathematics. However applying many different methods appropriately would help each student gain some understanding of every mathematics lesson taught by the teacher. The mathematics teacher must use project, cooperative and other interactive teaching methods in teaching mathematics to make the subject meaningful to the students. A variety of teaching methods should be used appropriately by

the mathematics teachers to facilitate the students' learning of mathematics. Battista (1999), Ball and Bass (2000) assert that if the teachers do not blend content with teaching process effectively, then the growth of the students' mathematical reasoning and problem solving skills will be stunted in the classroom. The key concept of teaching any subject is to help the students develop and grow in that subject. Teachers of mathematics must learn ways to help their students develop mathematically. This would be done by the students getting clear understanding of mathematics lessons they are taught. Teacher training institutions must engage their teacher trainees into adopting and applying more elaborate contemporary teaching strategies combined with content-specific subject areas. This will enable the trainees to do likewise after their graduation from the training programs, for it is noted that people tend to teach the way they were taught!

## **CHAPTER FIVE**

### **SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS**

This chapter presents the summary of the findings of the study. The chapter also presents the conclusions of the study which are based on the key findings discussed in Chapter Four. Also, this chapter provides the recommendations and the suggestions for further research based on the key findings.

#### **Summary**

This study described the perception of twelfth grade students of fourteen purposively selected senior high schools in Nimba County of their mathematics teachers' teaching styles. The study also described the perception of the senior high school mathematics teachers of the provision of in-service education and training (INSET) programmes in these high schools. Also, the study described the trends of the twelfth grade students' performance in the Liberia Senior High School Certificate Examination (LSHSCE) mathematics. Furthermore, the study investigated twelve grade students' achievement in the LSHSCE mathematics in the fourteen schools and how it is influenced by teacher characteristics (training status, subject area specialisation, academic qualification, and years of teaching experience).

The study involved 290 respondents comprising 280 twelfth grade students and 10 teachers teaching senior high school mathematics. Twenty twelfth grade students were selected at random from each senior high school.



Questionnaires and data sheet were used to gather data for the study. The data sheet was used to collect past twelfth grade students' LSHSCE mathematics grades. The grades were analysed using frequency distribution and percentages of the Statistical Package for Social Sciences (SPSS). Excel produced graphs to show clear pictures of the trends of the students' performance in the LSHSCE mathematics for the four consecutive academic years (2004/05 – 2007/08). One Way Analysis of Variance (ANOVA) and the Duncan Multiple Range Test (DMRT) analysed the students' performance in the LSHSCE mathematics in relation to the teachers' characteristics (training status, subject area specialisation, academic qualification, and years of teaching experience). Four key research questions were formulated and later addressed.

### **Key Findings of the Study**

1. The mathematics teachers used mixed teaching styles: student-centred and teacher-centred approaches. The mathematics teachers reviewed past mathematics homework questions, quiz questions and test questions with the students in order to reinforce the students' performance in mathematics. However, the teachers rarely used group activities to teach the students. Again, the teachers seldom used teaching-learning aids in teaching most of the mathematics lessons.
2. Short-term in-service teachers' workshops were organised, sponsored, and conducted internally by some of the selected schools. The provision of in-service education and training (INSET) programmes for the mathematics teachers was inadequate. INSET programmes were not organised for four of the ten mathematics teachers. INSET programmes provided for the six mathematics teachers were general: the programmes did not focus on mathematics subject specific-content areas. The topics treated most were

lesson planning, lesson presentation, testing and evaluation, and classroom management. The Government of Liberia and other stakeholders kept a low profile in sponsoring and conducting in-service teachers' workshops.

3. The twelfth grade students of the selected senior high schools in Nimba County are not performing well in the Liberia Senior High School Certificate Examination (LSHSCE) mathematics. Although the pass rate has increased over the years, however, the students are making ordinary passes which have poor quality. For example, the students are making 7 and 8 which are the lowest passes on the LSHSCE mathematics.

4a. The training status of high school mathematics teachers is positively related to (and may have effect on) the performance of high school students in mathematics. Twelfth Grade students taught by highly trained mathematics teachers performed better on the LSHSCE mathematics than the Twelfth Grade students taught by both less trained and untrained teachers teaching mathematics.

4b. Specialisation in mathematics for mathematics teachers is positively related to (and may have had positive impact on) the achievement of the Twelfth Grade students in LSHSCE mathematics in the selected schools. Possessing a major or a minor in mathematics or in mathematics related subjects is positively related to (and may have had positive effect on) students' achievement in mathematics.

4c. The qualification of the high school mathematics teachers is positively related to (and may have had positive effect on) students' performance in LSHSCE mathematics. Majority of the mathematics teachers who taught the Twelfth Grade classes are not qualified. The number of mathematics teachers in the senior high schools in Nimba County is inadequate. Teachers of other

academic disciplines are used as mathematics teachers due to the shortage of qualified mathematics teachers.

4d. Many of the high school mathematics teachers are found to be inexperienced. “Mixed effect” of teachers’ experience on students’ achievement (chronological years of teaching experience are not linearly or uniformly related to achievement).

### **Conclusions**

The present study reveals that the teachers teaching mathematics in selected senior high schools in Nimba County are using both student-centred and teacher-centred approaches. The teachers however, seldom use a variety of teaching-learning aids in their mathematics lessons. Moreover, the teachers rarely engage the students doing mathematics in small activity groups. Kochhar (2004) observes that effective teaching supports the use of a variety of teaching strategies. Mathematics teachers must therefore adopt and use a variety of teaching approaches in their lessons.

The study also reveals that the mathematics teachers perceive the provision of in-service education and training (INSET) as being inadequate to their needs. INSET is not provided for 40 % of the mathematics teachers who took part in the study. INSET is provided by some of the schools for their teachers on a short-term basis. The INSET provided is not in mathematics specific content areas. Also, the trends of the students’ performance in the LSHSCE mathematics reveal that the twelfth grade students in the selected schools in Nimba County are not performing well in the LSHSCE mathematics. The number of students passing LSHSCE mathematics has increased but the students are only making ordinary passes.

Finally, the present study shows that the mathematics teachers' characteristics (training status, subject area specialism, academic qualification, and teaching experience) positively influence students' achievement in LSHSCE mathematics. Jackson (1982) declares that in the absence of the adequate cadre of qualified teachers, the implementation of the curriculum and the attainment of educational goals are impossible.

### **Recommendations**

Based on the findings of the research, the following recommendations were made:

1. The authorities of Nimba County School System should encourage the teachers teaching mathematics to adopt and use many teaching styles as possible. Also, the mathematics teachers should make the teaching and learning of mathematics interactive and practical by engaging the students in hands-on activities, small group work, group discussions and group presentations, and individual as well as group projects. Again the mathematics teachers should use teaching-learning aids to deepen meaning and to connect language to symbols. The teachers must also have daily mixed practice and regular reviews for the students to further learning and maintain competence.
2. The relevant authorities of Nimba County School System should organise regular in-service programmes for the mathematics teachers to improve their content-based knowledge and teaching skills. Lessons in mathematics contents (geometry, trigonometry, word problems, etc.) should be included in the in-service programme topics. The teachers' in-service programmes should not be short-term programmes like one or two day's teachers' workshops. Mathematics teachers' in-service training programmes should constitute teachers conferences, symposia, etc.

3. The authorities of the Nimba County School System should collaborate with the Ministry of Education of Liberia to recruit trained and qualified mathematics teachers for the senior high schools in the county. This could be done by improving the conditions of work, providing incentives and bringing back on board trained, qualified, and experienced mathematics teachers who left for lucrative jobs.

4. The relevant authorities of Nimba County School System should collaborate with the Ministry of Education of Liberia to award scholarships to potential and deserving high school graduates to pursue studies in mathematics education. This teacher training initiative by the county school authorities will help to train and qualify more mathematics teachers and reduce the number of untrained and unqualified mathematics teachers in the classes.

#### **Suggestions for Further Research**

A few issues related to the study could not adequately be investigated. These issues are being suggested for further research.

1. The present study should be replicated in the remaining parts of the county as well as in other counties in Liberia in order to be able to make generalisation of conclusions.
2. A similar study should be carried out at the junior high school level.
3. The study should also be carried out in other subject areas like English and science which are core to the curricula at the different levels of education in Liberia.

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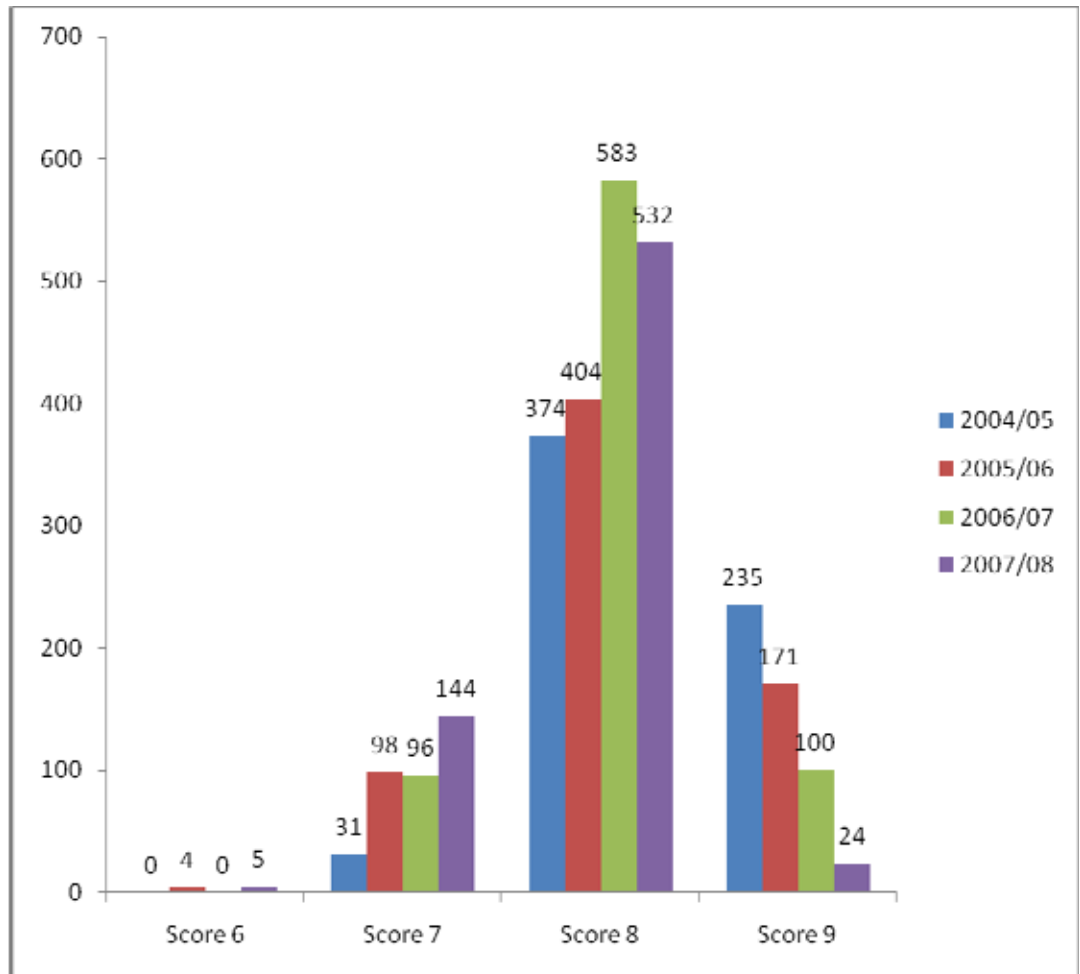
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## APPENDICES

### Appendix A: Trends in Students' Performance in LSHSCE Mathematics in Selected Schools





## Appendix B: Letters of Introduction


	<b>DEPARTMENT OF SCIENCE AND MATHEMATICS EDUCATION</b> <i>TELEGRAMS &amp; CABLES:</i> UNIVERSITY, CAPE COAST <i>TELEPHONE:</i> 042-32440/4 EXT. HEAD: 202 <i>OFFICE:</i> 042-34890	
Your Ref.:	Our Ref.:	Date:
Our Ref: SED/045/		17 <sup>th</sup> November, 2008.

**TO WHOM IT MAY CONCERN**

The bearer Joseph Flekpedolo Younn is an M.Phil (Mathematics Education) student in the Department of Science and Mathematics Education of this University. I shall be grateful if you could assist him to collect information and data from your institution or establishment.

Thank you for your support and co-operation.

Yours faithfully,

  
Prof. Benjamin A. Eshun

DEPARTMENT OF SCIENCE & MATHEMATICS EDUCATION  
FACULTY OF EDUCATION  
UNIVERSITY OF CAPE COAST



Office of the Deputy Minister/Instruction

REPUBLIC OF LIBERIA  
**MINISTRY OF EDUCATION**

P. O. BOX 10 - 9012  
1000 MONROVIA 10, LIBERIA  
WEST AFRICA



December 8, 2008

Dear Colleagues:

**REQUEST FOR COOPERATION WITH RESEARCH PROJECTS**

I am pleased to announce that the six (6) scholarship awardees for the Masters of Education Degree Program at the University of Cape Coast, Republic of Ghana have returned to Liberia to collect data for their research work. Please consider this as a letter of introduction to these pioneer educators. This is a new beginning in our educational system in Liberia.

I am asking that all County Education Officers (CEOs), District Education Officers, (DEOs) Principals and students give them all necessary cooperation in helping them to collect the data that they need.

The names of the six scholarship awardees are listed below. They are prepared to contact the County, and District Education officers for an appointment to discuss their proposed research prior to going into the schools.

1. Cecelia Cassell
2. Pauline T. Brown
3. Moriah G. Wisseh
4. Joseph F. Younn
5. Mulbah Z. Forkpah
6. Morris L. Ken

Thank you for your usual cooperation.

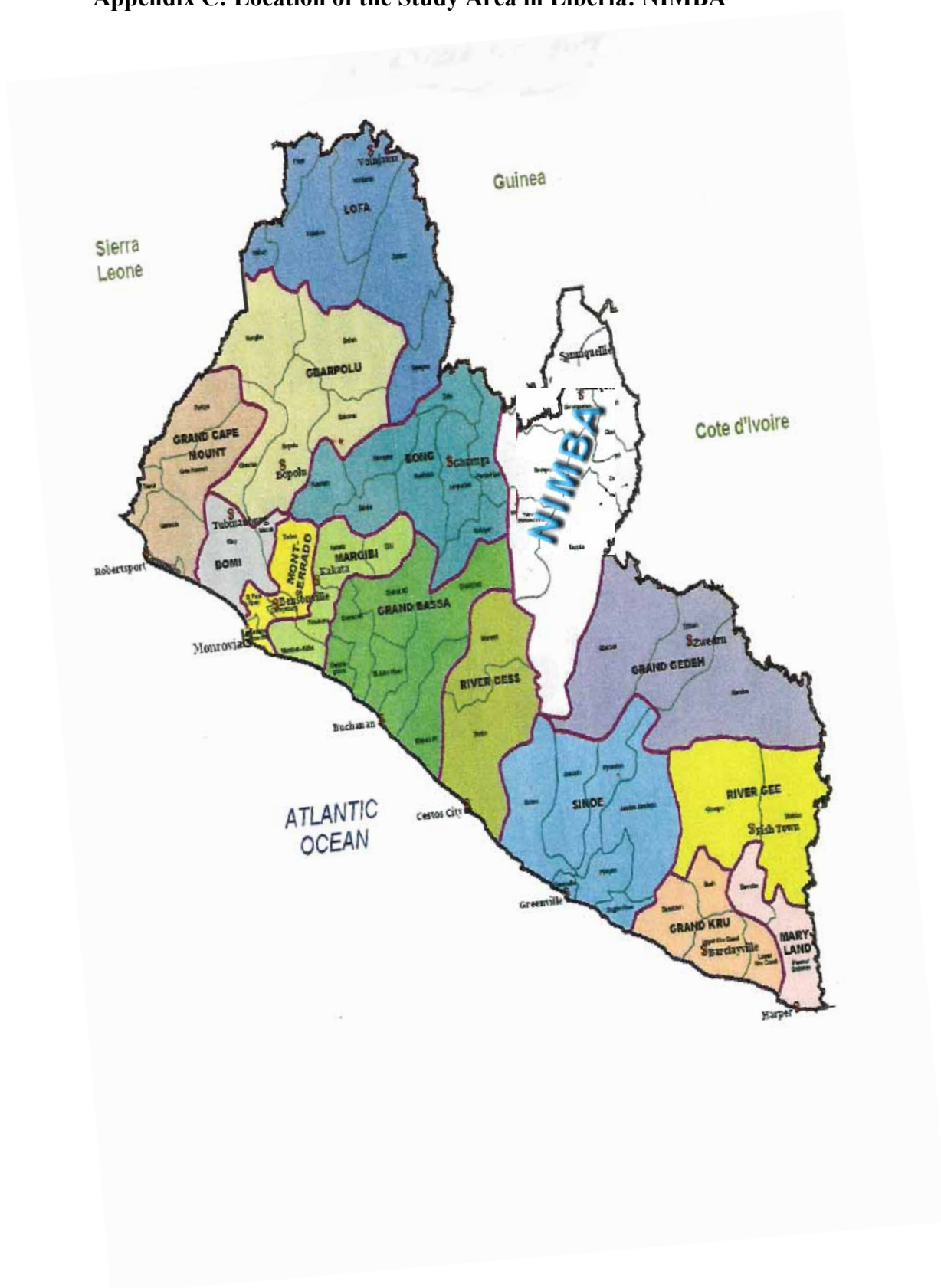
Sincerely yours,

Hester Williams-Catakaw (Mrss.)

**DEPUTY MINISTER/INSTRUCTION**

Accelerated Education for Accelerated Development

**Appendix C: Location of the Study Area in Liberia: NIMBA**



**Appendix D: A Model of Mathematics Teacher Characteristics**



**Appendix E: Teacher Questionnaire**

**NIMBA COUNTY SCHOOL SYSTEM**

**12<sup>th</sup> GRADE MATHEMATICS TEACHER BACKGROUND SURVEY  
QUESTIONNAIRE**

This questionnaire you are being kindly requested to complete, forms part of a study of the influence of teacher characteristics on students' achievement in mathematics. Your responses, which will remain completely anonymous, will help the researcher to help teachers improve the teaching and learning of mathematics in the participating schools.

Please complete the questionnaire as honestly as you can.

Thank you for your help.

SCHOOL: \_\_\_\_\_ OWNERSHIP \_\_\_\_\_

SCHOOL DISTRICT \_\_\_\_\_ TOWN \_\_\_\_\_

DIRECTION: Make a tick (√) in the space against the response that applies to you. Also fill in the blank where necessary.

1. Your highest qualification is

A. C-Certificate ( )

B. B-Certificate ( )

C. Diploma ( )

D. AA-Certificate

E. B. Sc. ( )

F. Others: Specify \_\_\_\_\_

2. Your highest qualification is in:

A. Geography ( )

B. Economics ( )

- C. Mathematics ( )
  - D. Physics ( )
  - E. Chemistry ( )
  - F. Others: Specify \_\_\_\_\_
3. Your minor subject area is:
- A. Chemistry ( )
  - B. Physics ( )
  - C. Economics ( )
  - D. Geography ( )
  - E. Mathematics ( )
  - F. Others: Specify \_\_\_\_\_
4. For how long have you taught senior high school mathematics?
- A. 0-4 years ( )
  - B. 5-10 years ( )
  - C. 11-16 years ( )
  - D. 17-22 years ( )
  - E. More than 22 years ( )
5. Give the exact number of years you have taught senior high school mathematics for \_\_\_\_\_
6. Is your qualification from a teacher training institute?
- A. Yes ( )
  - B. No ( )
7. If yes to item 6, please write the name of the teacher training institute.  
Also give the year of attainment and the name of the country in which the institute is located.

Name.....

Year.....

MATHEMATICS TEACHER SKILLS AND PROFESSIONAL DEVELOPMENT PROGRAMS.

In items 8 and 9, please respond by stating the extent to which you agree or disagree with the given statement.

8. In-service teacher training workshops are essential to the improvement of my subject-content delivery and professional skills.

A. Strongly Disagree ( )

B. Disagree ( )

C. Undecided ( )

D. Agree ( )

E. Strongly Agree ( )

9. In-service teacher training workshops are organized for me to attend.

A. Never ( )

B. Rarely ( )

C. Sometimes ( )

D. Often ( )

E. Always ( )

*NOTE: Responses to items 10, 11, 12, 13, and 14 are based on response to item 9 and some of the items may not apply to you if you have answered "never" to item 9.*

10. The in-service teacher workshops I have attended were sponsored by:

A. Individual school ( )

B. Community school system ( )

- C. Ministry of Education ( )
  - D. Non-governmental Organizations ( )
  - E. Central school administration ( )
11. Give the frequency of the in-service teacher training workshops in your area of specialization.
- A. None in a year ( )
  - B. Once in a year ( )
  - C. Once a semester ( )
  - D. Twice a semester ( )
  - E. Three times a year ( )
12. Give the duration of the in-service teacher training workshops in your area of specialization.
- A. 1-2 days ( )
  - B. 3-4 days ( )
  - C. 5-6 days ( )
  - D. 7-8 days ( )
  - E. 9-10 days ( )
  - F. Others: Specify \_\_\_\_\_
13. Show the topics treated at the in-service teacher training workshops you have attended. Select as many as applicable.
- A. Lesson Planning ( )
  - B. Lesson Presentation ( )
  - C. Classroom Management ( )
  - D. Testing and Evaluation ( )
  - E. Topics in Mathematics/ Mathematics related subjects ( )



F. Others: Specify \_\_\_\_\_

14. Give the extent to which the in-service teacher training workshops you have attended are relevant.

A. Not Relevant ( )

B. Rarely Relevant ( )

C. Sometimes Relevant ( )

D. Often Relevant ( )

E. Always Relevant ( )

## Appendix F: Twelfth Grade Student Questionnaire

The questionnaire you are being asked to complete is part of a study which is intended to help increase students' achievement in mathematics. Please complete the questionnaire as honestly as you can. Your responses will remain completely anonymous. DO NOT WRITE YOUR NAME.

**NAME OF SCHOOL:** \_\_\_\_\_

**NAME OF SCHOOL DISTRICT:** \_\_\_\_\_ **TOWN:** \_\_\_\_\_

Gender: Tick one that applies to you. (Boy), (Girl).

**DIRECTION: Make a tick (✓) in the space against the correct response.**

**Each statement or question has five possible responses. Tick only one which you consider as the most appropriate response to the statement/question.**

1. My mathematics teacher comes to school everyday

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

2. My Mathematics teacher is in school and on time.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

3. My mathematics teacher allows me to ask questions.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

4. My mathematics teacher knows mathematics very well.

1 Strongly Disagree ( )

2 Disagree ( )

3 Undecided ( )

4 Agree ( )

5 Strongly Agree ( )

5. My mathematics teacher takes time to explain each lesson  
for me to understand before he/she goes to a new lesson.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

6. We work in small groups during mathematics class discussions.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

7. My mathematics teacher uses variety of teaching materials to teach me mathematics.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

8. My mathematics teacher uses simple words that make me understand the mathematics lessons.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always

9. My mathematics teacher marks and returns my quiz papers, test papers, home work papers, etc on time.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

10. My mathematics teacher makes sure I understand the mathematics lessons well before he/she goes to a new topic.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

11. My mathematics teacher gets annoyed with me.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

12. I learn lot of mathematics from group activities  
organized by my mathematics teacher.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

13. My mathematics teacher only talks, explains  
and writes mathematics notes on the chalkboard.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

14. My mathematics teacher relates new mathematics  
lesson to past mathematics lessons.

- 1 Never ( )
- 2 Rarely ( )
- 3 Sometimes ( )
- 4 Often ( )
- 6 Always ( )

15. My mathematics teacher gives uses of mathematics in other subject areas like biology, physics, chemistry, geography, etc.

- 1 Never ( )
- 2 Rarely ( )
- 3 Sometimes ( )
- 4 Often ( )
- 5 Always ( )

16. My mathematics teacher uses extra time to prepare me for WAEC mathematics examinations.

- 1 Never ( )
- 2 Rarely ( )
- 3 Sometimes ( )
- 4 Often ( )
- 5 Always ( )

17. I score very good grades in mathematics homework, quizzes, tests and examinations given by my mathematics teacher.

- 1 Never ( )
- 2 Rarely ( )
- 3 Sometimes ( )
- 5 Often ( )

5 Always ( )

18. My mathematics teacher reviews mathematics homework questions, quiz questions and test questions before he or she goes to teach new lessons.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

19. My mathematics teacher puts me out of class to do punishment work when mathematics lesson is going on.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

20. My mathematics teacher rushes with the mathematics lessons.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

21. My mathematics classes are relaxed and the mathematics lessons are very interesting.

1 Never ( )

2 Rarely ( )

3 Sometimes ( )

4 Often ( )

5 Always ( )

22. Within the last three months, how many times has your mathematics teacher been absent from school?

(1) 0-1 time ( )

(2) 2-3 times ( )

(3) 4-5 times ( )

(4) 6-7 times ( )

(5) More than 7 times ( )

23. The number of mathematics homework assignment my mathematics teacher gives me in a marking period is:

(1) 1-2 assignments ( )

(2) 3-4 assignments ( )

(3) 5-6 assignments ( )

(4) 7-8 assignments ( )

(5) 9-10 assignments ( )



**Appendix G: Data Sheet for Collection of Information on Twelfth Grade  
Students' Performance on LSHSCE Mathematics for 2004/2005 –  
2007/2008**

NAME OF SCHOOL.....

OWNERSHIP OF SCHOOL.....

NAME OF SCHOOL DISTRICT.....

TOWN.....

SCORE	2004/05	2005/06	2006/07	2007/08
	NO. OF STUDENTS	NO. OF STUDENTS	NO. OF STUDENTS	NO. OF STUDENTS
1				
2				
3				
4				
5				
6				
7				
8				
9				
TOTAL				