



**Michigan
Technological
University**

Michigan Technological University
Digital Commons @ Michigan Tech

Dissertations, Master's Theses and Master's Reports

2018

EFFECTS OF APPLYING STUDENT-CENTERED TECHNIQUES IN MATHEMATICS ACHIEVEMENT: A CAMEROON CASE STUDY

Jomara Alexandra Laboy Rivera
Michigan Technological University, jalaboyr@mtu.edu

Copyright 2018 Jomara Alexandra Laboy Rivera

Recommended Citation

Laboy Rivera, Jomara Alexandra, "EFFECTS OF APPLYING STUDENT-CENTERED TECHNIQUES IN MATHEMATICS ACHIEVEMENT: A CAMEROON CASE STUDY", Open Access Master's Report, Michigan Technological University, 2018.
<https://doi.org/10.37099/mtu.dc.etr/667>

Follow this and additional works at: <https://digitalcommons.mtu.edu/etr>



Part of the [Bilingual, Multilingual, and Multicultural Education Commons](#), [Curriculum and Instruction Commons](#), [Educational Methods Commons](#), and the [Science and Mathematics Education Commons](#)

EFFECTS OF APPLYING STUDENT-CENTERED TECHNIQUES IN
MATHEMATICS ACHIEVEMENT: A CAMEROON CASE STUDY

By

Jomara Alexandra Laboy Rivera

A REPORT

Submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

In Applied Science Education

MICHIGAN TECHNOLOGICAL UNIVERSITY

2018

© 2018 Jomara A. Laboy Rivera

This report has been approved in partial fulfillment of the requirements for the Degree of
MASTER OF SCIENCE in Applied Science Education.

Department of Cognitive and Learning Science

Advisor: *Dr. Kedmon Hungwe*

Committee Member: *Dr. Shari Stockero*

Committee Member: *Dr. Amy Lark*

Department Chair: *Dr. Susan Amato-Henderson*

To the people of Shisong

Table of Contents

List of figures	vi
Acknowledgements	vii
Abstract.....	viii
Chapter I: Introduction	1
Context of Study.....	3
History of Cameroon.....	3
Education System.....	4
Present-day Cameroon	6
Statement of the Problem	8
Statement of Question and Hypotheses.....	9
Definitions & Abbreviations	12
Organization of the Project.....	13
Chapter 2: Literature Review	14
<i>Instructional Strategies</i>	15
<i>English Literacy Skills</i>	16
<i>Math Literacy</i>	18
<i>Interest in Mathematics</i>	18
<i>Study Habits</i>	19
<i>Home Background</i>	19
<i>Owning the Cameroonian Math Textbook</i>	20
Chapter 3: Research Design and Methods.....	21
Participant's Context	21
Sample Selection	23
Timeline.....	24
Instruments	25
Procedure.....	27
Data Analysis	28
Ethics	29

Chapter 4: Results and Discussion	30
Results	30
Students' Mathematical Achievement	30
Influencing factors.....	33
English Literacy	33
Math Literacy	34
Interest in Math	35
Study Habits	35
Home Background	36
Owning the Cameroonian math textbook	36
Teacher Effect	37
Discussion	37
Chapter 5: Conclusions and Recommendations	43
References	48
Appendix A: Math Pre and Post Test	52
Appendix B: Math Sequence One Test	44
Appendix C: Literacy Test	46
Appendix D: Student Questionnaire.....	47
Appendix E: Teacher Questionnaire	48
Appendix F: Copyright documentation	49

List of figures

Figure 1.1 Map of Cameroon..	4
Figure 4.1: Distribution Plot for Experimental Schools (GHS Shisong and GHS Kiyan)	28
Figure 4.2: Distribution Plot for Control Schools (St. Francis and St. Peters).....	29
Figure 4.3: Math Sequence One scores per school.....	33

Acknowledgements

Special thanks to:

Kumbo Math Committee:

Tamanji Marcel

Mdm. Wirba Efrida

Nawain Francis

Edwin Bah

Teachers and administration of GHS Shisong

Teachers and administration of GHS Kiyan

Teachers and administration of St. Francis

Teachers and administration of St. Peters

Peace Corps Cameroon staff:

Precious Teh

Francis Vernyuy

Kenyan Hunter

Graduate Committee Members, especially Dr. Kedmon Hungwe

Nelson Lemnyuy

My family especially Mami and Tío Rey

And to all that one way or another accompanied me through this journey.

Abstract

Effects of Applying Student-Centered Techniques in Mathematics Achievement: A
Cameroon Case Study

By:

Jomara A. Laboy Rivera

This study investigated the effects of using student-centered techniques in math Form 2 (Eighth Grade) and the relationship among English literacy, Math Literacy, interest in math, study habits, home background and owning the Cameroonian math textbook with mathematical achievement. Data were collected from four different schools in the North West region of Cameroon. The experimental schools (GHS Shisong and GHS Kiyan) used student-centered techniques while the control schools (St. Peters and St. Francis) used teacher-centered techniques. Results showed that there was an improvement on mathematical achievement in one of the experimental schools due to the use of student-centered techniques. There was also a positive correlation between achievement and math literacy, math interest and study habits. English literacy, home background and owning the textbook didn't show any significant correlation with achievement. Based on these findings we suggest further research with a similar population and longer intervention time.

Chapter I: Introduction

“What are we going to do with these students? No matter what we do, they keep failing the exams. They just don’t care. My students can’t even read or write, how do you expect them to pass the exams?” This was from an actual conversation I heard between teachers during my first staff meeting in the school in which I was going to serve as an Education Peace Corps volunteer in Cameroon. My primary job as a volunteer was to teach math and science to secondary school students in a rural village in the North West of Cameroon for two years. Who would have thought that conversations like this would lead me to extend my service one more year and complete a study to investigate the effects of student centered-techniques and other factors influencing students’ achievement in mathematics?

The school I was posted to teach was the Government High School (GHS) Shisong, in the North West region of Cameroon. Students repeating classes and failing national exams were signs of the low achievement in the school. The teachers in my school were extremely concerned with the students’ low achievement. The low achievement was a substantial problem, for which, unfortunately, no one seemed to have a solution.

Low achievement among students was not unique to GHS Shisong. Bipoput (2007) explains:

The schooling system in Cameroon is faced with a number of problems, including overall poor performance as reflected in high repetition rates in primary schools and inadequate results in secondary

school examinations – and difficult teaching and learning conditions as it is witnessed by the insufficient attention paid to improve schools' performance in terms of educational objectives, teaching models, teaching and learning content, teaching methods and the affective environment in school and the importance attached to the individuals differences.

According to UNESCO Center for Statistics, the percentage of Cameroonian repeaters for 2015 in primary schools was 12.17% compared to 2.94% of repeaters in Kenya (UNESCO, 2015). The number of Cameroonian repeaters in secondary general education was 17.6% in 2014 as reported by the World Bank collection of development indicators. In Cameroon, the passing rate in the General Certification of Education (GCE) examination for Ordinary Level Mathematics has not gone above 30% in the past 15 years (Akoko, 2010). It seems that many around Cameroon shared the desperation faced by the teachers at my school.

A student needs to repeat a Form (Grade) if he or she has less than eight marks or points out of twenty in his or hers annual average score. A student is promoted to the next grade level if their annual average is eight or above. The grading system in Cameroon is done based on the scores of each of the six sequence exams given per year. Exams are calculated out of 20 marks or points and to pass each sequence exam the student needs to score ten or above. Sometimes parents don't want their students to repeat the grade so they push the administration to promote the students regardless of their mark. Schools usually accept this because if they don't they would loose the fees from that student since there will always be another school that would accept them.

Context of Study

History of Cameroon

To make sense of why the Cameroon Education System is facing these problems, let's recount parts of the history of Cameroon as told by Mathew Akoko (2010). Western education was introduced in Cameroon during 1844 when missionaries from Britain settled in the South West Region. The education was mainly focused on religious education to primary school age children and the missionaries also taught reading, writing and arithmetic. The main language of instruction was English. At this time, Cameroon had no central government, only local chiefs. Germany was the colonial power from 1884 to 1916. During the World War I, Franco-British forces attacked the German armies in Cameroon. After the German armies were defeated, a mandate of the League of Nations divided Cameroon between France and Great Britain. Out of the ten regions of Cameroon, two (North West and South West) were given to Great Britain and the other eight (Center, East, West, South, Littoral, Adamawa, North and Extreme North) were given to France. After World War II the people of both French and British Cameroon demanded their independence. French-speaking Cameroon became independent in 1960. On the other hand, the English-speaking Cameroonians, under a United Nations supervised plebiscite, were given the option to reunite with the French Cameroon or unite with Nigeria. On February 11, 1961 they voted to reunite with French Cameroon. Twenty-three years later Cameroon was named the Republic of Cameroon (Akoko, 2010).



Figure 1.1 Map of Cameroon. Image source: <https://www.theguardian.com/global-development/2018/may/30/cameroon-killings-escalate-anglophone-crisis>. See Appendix F for full attribution and copyright licensing information.

Education System

Cameroon has adopted two main official languages, French and English, as well as two different education systems. The English-speaking regions follow the Anglophone educational system and the French-speaking regions follow the Francophone educational system. Primary school education is structured the same way in both systems. The entry age for primary school is 6 years, and it goes from Class 1 to Class 6, which is equivalent to Grades 1 to 6 in the United States. After completing six years of primary school, students take the Certificat d'études Primaire (CEP) in the French system and the First School-Leaving Examination (FSLE) in the Anglophone system. Primary education is compulsory and free, although parents still need to buy uniforms and supplies. Secondary education is compulsory until the age of 14, but not free. In both systems

secondary education lasts seven years, but it is divided differently. The secondary education in the Anglophone system starts with Form 1 to Form 5, which is equivalent to Seventh to Eleventh grade in the United States. Then after taking the GCE Ordinary Level after five years, students pass to Lower Sixth and Upper Sixth, equivalent to senior year of high school in the United States. After the last two years in the upper levels the students need to write the GCE Advanced Level examination. The Francophone system also takes seven years, but the division varies, starting from 6ème (Seventh Grade) to 3ème (Tenth Grade), then the last three years are 2nde, 1ère and Terminal. After the first four years, students write the Brevet d'Etudes de Premier Cycle (BEPC) examination. Then, after the next two years, they take the Probatoire Examination and finally Baccalaureate at the end of the seventh year (Akoko, 2010). The academic year goes from September to June, leaving the last month to write the examination papers. The GCE Advanced Level for the Anglophones and the Baccalaureate for the Francophones are the entrance exams for the universities in Cameroon. Cameroonian education system has seven years total of secondary school compared to the sixth years in the United States. A Bachelor degree in Cameroon takes around three years while in the United States normally it takes four years to complete.

Cameroon has public and private schools. The government and Parent Teacher Associations subsidize the public schools in the community making them relatively accessible to Cameroonians. The annual fee in a public school like GHS Shisong is around 27,500 CFA (\$45). This fee was too much for some of the students in my community and they were usually sent out of school for failing to pay the school fees.

Private schools are mostly run by missionaries and are usually more expensive since they are typically boarding schools providing room and board. The annual fee in a Catholic private school like St. Francis Comprehensive College is around 194,000 CFA (\$315). Private schools typically have more resources and fewer students per classroom than the public schools.

Present-day Cameroon

The study took place in Kumbo, the second largest town in Bui Division located in the North West region of Cameroon. The North West region is one of the two Anglophone regions in the country. According to the Kumbo Council Development Plan (2011), Kumbo is divided in 43 villages and has a population of 127,538 in an area of 630 square kilometers (243 square miles). It is 110 kilometers (42 miles) from Bamenda, the regional capital of the North West (PNDP, 2011). I lived in a village called Shisong with a population of 7,048 people (PNDP, 2011). The dominant group of people in Kumbo are the Nso'. Their main language is Lamnso', but they also speak English, Pidgin and other dialects. "The Nso' are a community who live off subsistence farming, mainly corn and beans. Most of the children live in mud brick houses without water and without electricity. They have to work a lot to take care of younger siblings and help their parents in the farm" (Lamm, 2017).

Since the Nso' community is mostly composed of farming families; the students find it difficult to consistently attend school. Especially during the harvesting season, September and March, students miss school so they can help their parents in the farm. It is hard to keep interest in school when you can't follow the subjects due to a sporadic

attendance. Not paying the school fees also reduces attendance. The school administration removes students from school when they don't pay the fees and the student can't return to school until they pay the money.

Another reason that impacts the low interest in school is the lack of academic role models. "Among the Nso", the majority of the 'role models' are siblings or peers who stay together without adults for much of the day and are charged with the care and supervision of younger siblings" (Nsamenang & Lamb, 1995). In addition, the majority of these kids' parents never finished secondary school. Most of the people in the villages don't finish school because they need to make money to support their families. For example, it was observed that boys usually drop out of school to work as "bike man" or cutting rocks to make concrete for construction. In the case of the girls, they tend to leave school early when they get pregnant (Nsamenang & Lamb, 1995). The dropout rate for primary school kids in 2011 was 23 percent (World Bank, 2014). The reality is that it is hard to commit and prioritize school when students are trying to fulfill other basic needs.

I was living and teaching in the Anglophone part of Cameroon for two years. I was removed from my village, Shisong, during November 2017 due to the political unrest in the Anglophone regions. There are ongoing political grievances with the Anglophones making demands for equal treatment. The strike started when lawyers and teachers joined forces to claim to be treated by the Cameroonian government the same way they treat lawyers and teachers from the Francophone regions. The Anglophones feel marginalized by the government and are asking for good governance. The struggle has escalated to the

point that some separatists Anglophones claim to want independence from Cameroon and want to start their new country, Ambazonia. Many more people have been affected since then. The students of the Anglophone regions missed school from November 2016 to November 2017. To this day, many children changed schools or are not going to school for fear of the repercussion from the separatists.

Statement of the Problem

In that first staff meeting in GHS Shisong, the principal asked the teachers what they thought could be causing the students' low achievement in mathematics. After a long discussion between the teachers and the administration it was concluded that the overuse of teacher-centered teaching techniques in combination with other six possible influential factors might be the reason for students' low achievement in mathematics. The six possible influential factors were narrowed down to: (1) English literacy, (2) math literacy, (3) interest in mathematics, (4) study habits, (5) home background and (6) owning the Cameroonian textbook. At that moment, the teachers decided that something needed to be done if they wanted to increase their students' achievement.

Teachers developed the book *Math: One More Story* using student-centered techniques to pilot and test with math Form 2 (Eighth Grade equivalent) students. The focus of the book was to offer lesson plans to teachers to study if we could increase students' performance. The focus of this study was to test the book. Four schools were selected to participate in the study. Two schools would be the experimental schools using the student-centered techniques and the other two schools would be the control schools that would teach as they usually do. The control schools, both private, were Saint Francis

Comprehensive Collage, a private school 10 minute walk away from GHS Shisong through the hills of Shisong, and Saint Peters, another private school in Mbve a nearby town in Kumbo. The experimental schools, both public schools, were GHS Shisong and GHS Kiyen a five-minute bike ride away from St. Peters.

Statement of Question and Hypotheses

The aim of this study is to answer two specific questions, which, along with their hypotheses, are as follow:

1. Will the Form 2 students in the schools using student-centered techniques perform better than the Form 2 math students in the schools using teacher-centered techniques?

H_0 : The Form 2 students in the schools using student-centered techniques will not perform better than the Form 2 math students in the schools using teacher-centered techniques.

H_1 : The Form 2 students in the schools using student-centered techniques will perform better than the Form 2 math students in the schools using teacher-centered techniques.

2. Is there any relation between the following factors and students' achievement in mathematics?

- a. English literacy levels

H_0 : There is no correlation between English literacy levels and students' mathematical achievement.

H₁: There is a positive correlation between English literacy levels and students' mathematical achievement.

b. Math literacy levels

H₀: There is no correlation between math literacy levels and students' mathematical achievement.

H₁: There is a positive correlation between math literacy levels and students' mathematical achievement.

c. Interest in math

H₀: There is no correlation between interest in math and students' mathematical achievement.

H₁: There is a positive correlation between interest in math and students' mathematical achievement.

d. Study habits

H₀: There is no correlation between study habits and students' mathematical achievement.

H₁: There is a positive correlation between study habits and students' mathematical achievement.

e. Home background

H₀: There is no correlation between who the students live with and students' mathematical achievement.

H₁: There is a correlation between who the students live with and students' mathematical achievement.

f. Owning the Cameroonian math textbook

H_0 : There is no correlation between owning the Cameroonian prescribed math textbook and students' mathematical achievement.

H_1 : There is a positive correlation between owning the Cameroonian prescribed math textbook and students' mathematical achievement.

Definitions & Abbreviations

ANOVA – Analysis of variance. Statistical analysis used to measure the difference of two or more groups in an experiment.

Cameroon Education System - The education in Cameroon is divided in two systems: Anglophone and Francophone. In both systems primary school takes six years and secondary school takes seven years. Primary school is free and compulsory. Secondary school is compulsory until age 14 and it is not free.

Community Needs Assessment (CNA) – Survey given to a community to gather information about the community's strengths and weakness to determine a plan of action.

Competence Based Approach (CBA) – Prescribed method of teaching by the Cameroonian government that strives for the use of more real world and practical content.

Early Grade Reading Assessment (EGRA) – Test made by USAID to measure the reading level of learners.

English literacy – Ability to know how to read, write, listen and speak in English.

Form – Also referred as class. It is the grade level in the Anglophone education system. It goes from Form 1 to Upper Sixth. It is the equivalent to grades in the United States, going from Sixth grade to senior year of high school.

GCE – General Certification of Education, national exam for all subjects given to Form 5 students in the Anglophone education system.

GHS – Government High School.

Math literacy – Numeracy, capacity to speak the language of mathematics.

Mathematical achievement – Students' performance on a national or teacher-made test.

Students – Used synonymously with learners.

Subject – Refers to a class content. For this research the subject researched was mathematics.

UNESCO – United Nations Educational, Scientific, and Cultural Organization

USAID – United States Agency for International Development

Organization of the Project

The rest of the project is organized in four chapters. Chapter 2 discusses the literature review related to the research questions. Chapter 3 focuses on the research design and methods. Chapter 4 provides the results and discussion of the findings for the research. Chapter 5 provides a summary of the main findings, conclusions and suggestions for future work.

Chapter 2: Literature Review

The goal of this study was to find out what factors influence Form 2 students' mathematical achievement. The main question was to investigate if applying student-centered techniques in two Cameroonian math classrooms would affect the students' achievement more than at other two Form 2 classrooms not using student-centered techniques. Besides experimenting with the teaching methods we wanted to know what other factors might influence students' mathematical achievement.

Mathematical achievement is described as the students' performance in teacher made assessments or standardized assessment where they can show what they have learned (Nizoloman, 2013). There has been extensive research done in different parts of the world to identify the specific factors affecting students' achievement in math. Savas, Tas & Duru (2010) concluded that there are both internal and external factors that affect students' mathematical achievement. By internal factors they refer to the content and quality of the test items given by the teacher. By external factors they mean socioeconomic conditions, family background, school climate, language and students' attitude or interest towards math (Savas, Tas & Duru, 2010). Other researchers have identified personal student factors (e.g., low interest and numerical ability), teacher factors (Korau, 2006), textbooks, social background, school environment, and instructional strategies (Nizoloman, 2013). The study focused on the following external influential factors: instructional strategy, English literacy, math literacy, interest in mathematics, study habits, home background and owning the Cameroonian math

textbook and how they might relate to the students' mathematical achievement in the Cameroonian context.

Instructional Strategies

Nizoloman (2013) remarked that the low performance of students in mathematics can be attributed to how math is taught to students. The most common form of instruction in Cameroon is teacher-centered. From my observations, most of the teachers come to class and copy notes on the board and expect the students to copy silently and memorize the notes for the exam. There are few interactions between teacher and student during class period. The Cameroonian government has realized this is a problem of their education system and it is currently encouraging the use of the Competency Based Approach (CBA). CBA came to the Cameroonian governments' attention when they realized that their students performed poorly on international examinations (Gauthier, 2013) at the same time that they recognized an overuse of teacher-centered techniques in their schools. CBA was first introduced in Cameroon's secondary schools during the 2012 to 2013 academic year (Ndifor, 2014), with the purpose of moving from rote memorization to a more experiential and practical approach in school. This means creating special learning conditions that encourage students to deduct, formulate theories and problem solve using critical thinking (Bipoupout, 2007). "CBA seeks to bridge the wall between school or the classroom and everyday life" (Nkwetisama, 2012, p. 519). CBA promotes student-centered learning and inquiry.

Grouws (2000) found that mathematical achievement is improved when students are given the opportunity to discover new knowledge and equal opportunity to practice the skills acquired, allowing the students to connect mathematical concepts better. Classrooms that use small groups to work on activities and then do a whole class discussion perform better than classrooms that don't give anytime for group work (Grouws, 2000). A study done in Brazil confirms that engaging students in a variety of student-centered classroom activities has a positive effect in math achievement (Fuller, 1987).

For the past three years, the African Institute of Mathematical Science (AIMS) in Cameroon has piloted a program with the goal to train mathematics teachers in innovative student-centered techniques. AIMS study is still underway, but interviews done with some of the teachers participating on this program indicated that the use of student-centered techniques in their classrooms increased the mathematical achievement and interest of their students. The teachers observed an increase in attendance and participation in the classroom that led to higher marks in the math test (AIMS, 2018).

English Literacy Skills

“If you want to hide something from a Cameroonian put it in a book” – this is a common saying in Cameroon. In my time living in Cameroon, I noticed that there wasn't a big reading culture. As part of my Peace Corps service, I did a Community Needs Assessment (CNA) in Shisong and one of the questions was if they read. In the Form 2 class, 14 out of 25 students that completed the questionnaire said that they only read

when they have to and never for pleasure. The majority of the students answered that they read the Bible or the school notes. The article *Education-Cameroon: Teachers Give School System a Failing Grade* mentions that “more than half the children registered in school don’t have access to books because there is no policy for making books available. The books are distributed unfairly and they are expensive” (Africa News Service, 2005, pp. 16). To put it in context, it is a challenge to practice literacy skills in a place where there is a lack of books and a low reading culture.

“Cameroon is bilingual, but Cameroonians are not bilingual” – another common saying in Cameroon. In multilingual Cameroon, 247 indigenous languages are spoken besides the two official languages: French and English (Echu, 2004). For most of the students, English is their third language. The students in this study grow up speaking only their dialect Lamnso’, then they are introduced to Pidgin English in the community, and finally they are taught English and French formally in school. Both Lamnso’ and Pidgin English are prohibited on school property, but are still used by the students since they are most comfortable with these languages.

How does English literacy skills relate to math achievement? Research shows that reading comprehension is highly correlated to math application (Thurber et al., 2002). Other researchers like Rutherford and Vanderwood (2009) agree with Thurber. They measured the relationships between literacy and mathematical achievement in fourth and fifth grade students in California and found that reading comprehension is a predictor of math achievement. The higher reading comprehension skills, the better

students performed in the applied math assessment. On the other hand, they didn't find a significant relationship between reading fluency and math achievement.

Math Literacy

Math literacy, also known as numeracy or mathematical ability, is the capacity to speak the language of mathematics (Oxford, 2010). Nizoloman (2013) describes mathematical ability as the capacity to use or work with numbers and ideas related to numbers. In his research, he found that there is a significant positive relationship between students' mathematical ability and achievement in mathematics. The higher the mathematical ability of a student the higher the mathematical achievement would be. Rutherford and Vanderwood (2009) also support the fact that math skills and math literacy are significant predictors of applied performance in math.

Interest in Mathematics

Interest or attitude towards mathematics can be described as liking or disliking doing math, and can also be described as the emotional disposition towards mathematics (Ngeche, 2017). Research has shown that students who have a better perception or attitude towards mathematics tend to have better achievement in mathematics (Savas et al., 2010). A study done in Uganda supports the fact that mathematical achievement is positively related to the students' attitude and interest towards math (Nsubuga, 2015). A study performed with 400 students in the North West of Cameroon also showed a positive correlation between students' attitudes and mathematical achievement (Ngeche, 2017). The more interest and better attitude the student has towards math the more effort

he or she will put in the class. Gugliemi (2015) said that peers' perception of math can influence students' interest, as well as affecting the whole class performance in math.

Study Habits

Study habits are related to doing homework or assignments after class. A research conducted by Dickerson (2015) found that students' that don't do their homework perform lower compared to the students that do their homework most of the time. Other research also signals that the homework that is done and corrected has a significant positive correlation with mathematical achievement (Fuller, 1987). Additionally, the number of hours spent studying has a positive correlation with achievement within public schools in Cameroon (Ntondumu, 2010).

Home Background

A lot of research has been conducted in relation to how home background and education level relates to students' achievement. Home background refers to with whom the student is living and not necessarily to the socioeconomic level of the household, although this might be connected. Research conducted by Dickerson et al. (2015) shows that students that stay with parents or close relatives during the week performed better on math tests than the students that lived without their parents. Another research done by Cooksey (1981) mentions that students who live in small households (2-9 people) tend to perform better than students who live in larger households (10+ people). The same research mentions that students that live with educated parents perform better than students that live with uneducated family members or parents. In a study done in

Cameroon, students in who stay alone in mission boarding schools were found to perform better in class than students in public school due to the differences in resources among the two types of schools (Ntondumu, 2010).

Owning the Cameroonian Math Textbook

Research by Dickerson, McIntosh and Valente (2015) in Africa found that the students that don't own the textbook perform lower in the math test compared to the students that own the textbook. Ntondumu (2010) found that students that owned the required the textbook for the class performed better than their peers without the book. The general trend in third world countries is that lack of relevant mathematics textbook negatively affects the learning of mathematics (Ale, 2001).

Chapter 3: Research Design and Methods

To investigate how student-centered techniques, English literacy, math literacy, students' interest, home background, study habits and owning the Cameroonian math textbook affect Form 2 students' mathematical achievement, a collaborative quasi-experimental and correlation research design was applied in four schools in the North West of Cameroon.

Before designing the research a math committee was created in Kumbo to write the book *Math: One More Story* that includes the student-centered techniques to be tested. Some of the types of student-centered techniques used in this study through the book *Math: One More Story* were group work, Think-Pair-Share, whole class discussion, reading stories, inquiry, songs and games. This is a collaborative action research for the improvement of teaching and learning mathematics. In this chapter we will discuss the research design and methods for this study.

Participant's Context

A total of 230 Form 2 math students participated in the study. At the end of the study, due to the Anglophone strike and the closing of the schools, we had a total of 69 students among the four participating schools. We had two experimental schools and two control schools.

Experimental Schools

The two experimental schools were the public high schools GHS Shisong and GHS Kiyan. GHS Shisong is the school that I worked in as an education Peace Corps volunteer. This government school is located in Shisong and it's a relatively small school at the top of a hill. The whole school had around 200 students enrolled from Form 1 to Upper Sixth. At the beginning of the study, we had 45 students in the Form 2 math classroom and at the end of the study the number of students dropped to a total of 12 students. The second experimental school, GHS Kiyan is another government school located in Kiyan, a village in Kumbo. This school is closer to town and it has a bigger population. The school enrolled over 1,000 students and it also teaches from Form 1 to Upper Sixth. The number of students per classroom was larger compared to the other three participating schools. In the beginning of the study, we had 91 students in the Form 2 math classroom and at the end of the study the number of students was reduced to a total of 31. Both of the math teachers in the experimental schools adopted the student-centered techniques through the use of the book *Math: One More Story*. I was the teacher for Shisong and another teacher that was part of the math committee who helped develop the math book was the math teacher in Kiyan.

Control Schools

The two control schools were private schools: Saint Francis and Saint Peters. Saint Francis is located in the rural village of Shisong, around a ten-minute walk away from GHS Shisong. Saint Francis Comprehensive College is a Catholic boarding school with an enrollment of around 500 students. In the beginning of the study we had 45

students in the Form 2 math classroom and at the end of the study the number of students was reduced to a total of 15. The second control school was Saint Peters, which is a private Catholic secondary school with an enrollment of around 700 students. Saint Peters is located in Mbve, the most developed area of the three that form part of this study. St. Peters and GHS Kiyan are around a ten-minute bike ride away. In the beginning of the study we had 49 students in the Form 2 math classroom in St. Peters and at the end of the study the number of students was reduced to a total of 11. Both schools taught from Form 1 to Upper Sixth. The control schools were using teacher-centered techniques and the government prescribed math book *Mastering Mathematics*.

Sample Selection

School Selection Criteria

The four schools were selected for convenience of the researcher. GHS Shisong was selected because it is the school I was working in as a Peace Corps volunteer. The other three schools were selected for their proximity to GHS Shisong and the interest shown by the teachers and administration to participate in the study. The four schools follow the same Anglophone math curriculum. The school environments are slightly different since the two experimental schools are public and the two control schools are private. The four schools allot the same amount of time for math class a week; it is distributed as four periods of 45 minutes each.

Subject and Grade-level Selection Criteria

Mathematics was chosen as the subject for the study because it is where the students had the lowest achievement. Form 2 (Eighth grade) was chosen because it is a

time where the students have hopefully adapted to secondary school, but are not yet preparing for any national exams. Students normally start preparing for national exams starting in Form 4 (Ninth grade).

Teacher Selection Criteria

Teachers are assigned by the government in the public schools and by the school administration in the private schools. This means that the four math teachers that participated in the study were the teachers already assigned at the moment of the study to teach the selected Form 2 math classrooms in the schools selected.

Student Selection Criteria

All the 230 students enrolled in the respective Form 2 classrooms in the experimental and control schools were selected to participate in the study. At the end of the study the total amount of students was 69. Due to the political unrest in the North West, parents that could afford to send their students to schools in the Francophone regions sent them there and other students unfortunately dropped out of school.

Timeline

This study was launched at the beginning of 2016-2017 academic year. Five out of the ten competencies in the Form 2 math scheme of work were covered from September to November 2016. During November 2016 the schools in the Anglophone sector of Cameroon closed due to an ongoing strike against the government. Even though school timidly started again during November 2017, it was not safe to continue with the work. I was removed from my village and taken to the capital of Cameroon. I was

granted special permission to go back to Kumbo for a week in February 2018 to administer the final assessments for the study.

The timeline of assessments goes as follow: Math pre-test was given during the fourth week of September 2016. Then the Math Sequence One test was given during the third week of October 2016. The post-test along with the questionnaires were given during the first week of February 2018.

Instruments

In this study the instruments used to measure students' mathematical achievement and its relation to various factors are in the form of tests and questionnaires. The four schools administered the same tests and questionnaires.

1. A math concept pre-test and post-test (See Appendix A) for each of the competencies included in the schemes of work to measure students' achievement. The pre- and post-test are exactly the same and it was worth 20 marks, or points as it is referred in the United States. The students had one period of 45 minutes to answer the test. We also administered the Math Sequence One test to measure achievement after the first few months of teaching. For this test we allowed two class periods for a total of 90 minutes. The Sequence One test is also worth 20 marks (See Appendix B). To measure the students' achievement we quantified how many questions the students were able to answer correctly before and after our intervention. We took the difference between the math concept pre- and post-test to obtain Math Gain as one of our tools to assess achievement. We also

compared the results for the Math Sequence One test among the control schools (St. Francis and St. Peters) and the experimental schools (Shisong and Kiyan) to measure achievement. The four math teachers participating in the study developed these tests. The tests were printed out and given to each of the students. Before starting the test, each teacher would read for the students the instructions for the test and continue to monitor them throughout the test to ensure the integrity of the examination.

2. To measure literacy levels for English and math, we assessed students by administering a literacy test adapted from the Early Grade Reading Assessment (EGRA) developed by USAID (See Appendix C). The literacy test was administered in a one-to-one basis. The test consisted of giving the student one minute to read a passage aloud. The teacher administering the test kept track of the time and the words the student struggled with. After reading the passage, the passage was taken from the student and they continued to answer five comprehension questions about the passage, scored one mark each. The student had 15 seconds to answer each question. After answering the comprehension questions, the students were assessed in their math literacy levels. For the math literacy test, the students needed to identify five symbols and six math expressions correctly, for a total of 11 marks for the math literacy section. I and other two teachers not participating on the study were trained to administer the literacy test in the four schools.
3. The teachers in the math committee developed a questionnaire to collect demographic information and measure other factors that might influence students'

achievement. The student questionnaire uses a Likert scale (strongly disagree to strongly agree) to measure students' attitude or interest towards math and study habits. We also asked students to select which of these categories they fall into for home background: (1) students living in school; (2) living with both or one parent; and (3) students living with another family member. Another question was if they own the Cameroonian math textbook and the students had to select between yes and no (See Appendix D).

4. To account for the teacher factor we administered a teacher questionnaire with ten open ended questions to the four Form 2 math teachers. The questions were related to their teaching habits and their use of student-centered techniques (See Appendix E).

Procedure

The math content tests were written by all four participating math teachers to provide reliability. The teachers of each Form 2 math class oversaw the administration of the math pre-test and the math sequence one test. As mentioned before, these tests took one class period of 45 minutes and were administered in their respective classrooms. All teachers followed the same protocol when administering the test. The teachers would distribute the test and read the instructions to the students before they began the test. Each teacher marked their students' test following the key developed by the group of teachers.

The post-test, literacy test, and questionnaire were administered the same day. One period of 45 minutes was allotted to the math post-test and the second period was allotted for the questionnaire and the literacy test. Two teachers not related to the study, but

trained in the administration protocol, and I administered the three tests. The post-test and the questionnaire were administered in the classroom. The questionnaire was read to the students aloud and was completed by all the students in the classroom at the same time. The literacy test was completed individually and in a quiet location outside the classroom. The protocol to administer the literacy test was followed by the teachers administering the test. Student would come sit down in a desk in a quiet place and read the instructions. The teacher would keep the time while the student read. After the teacher would ask the comprehension questions, mark and make comments in the index card for that specific student. For the math literacy section of the test the teacher would point at the specific symbol or mathematical expression and the student would read it correctly. One mark or point was given for correct answers and zero for incorrect answers.

Data Analysis

The study used a mixed method approach to analyze the data. First, we calculated simple descriptive statistics, such as mean and standard deviation for each of the tests administered. Then we used inferential statistics to compare the results of the four schools to see if our intervention had any effect in the students' performance. To ANOVA was used to compare the means of the four different schools to find if there is any statistically significant difference. ANOVA was done with $p=0.05$ for the math pre-test, math sequence one test and the math gain between the pre-test and the post-test. Post hoc was used to find where the difference shown by ANOVA is coming from. The Pearson correlation analysis was used to measure if there was any correlation between

students' math achievement and literacy levels, math interest and study habits. We used an ANOVA, as well, to analyze if home background and the owning the Cameroonian math textbook affected achievement. Qualitative data was used to analyze the answers and patterns of the teachers' answers to the questionnaires.

Ethics

The efforts invested by teachers and Peace Corps volunteers in writing and testing the book *Math: One More Story* have been solely with the students in mind. All the teachers and students participating in the study, as well as the administration of the participating schools, were aware of its purpose. All data collected in the study will remain confidential. At no moment of the study the participants experienced anything that could harm them physically, emotionally or mentally.

Chapter 4: Results and Discussion

The purpose of this study was to find out if using student-centered techniques through the book *Math: One More Story* affect students' mathematical achievement. We also wanted to know if factors like English literacy levels, math literacy, interest in math, study habits, home background and owning a Cameroonian math textbook have any influence or relation to the students' achievement in math. Our main hypothesis was that the experimental schools using the student-centered techniques, GHS Shisong and GHS Kiyan, would have higher mathematical achievement than the control schools, St. Francis and St. Peters. We also hypothesized that literacy levels, math literacy, interest in math and study habits would have a positive correlation with students' achievement. In the case of home background we assumed that the students living with their parents would perform better than the ones living alone or with other family members. We also hypothesized that the student owning the government prescribed Cameroonian math textbook would perform better than the students without the textbook. To facilitate the description of the results we have divided them in subsections starting with the results for students' mathematical achievement due to the teaching intervention and a section per covariate or influential factor.

Results

Students' Mathematical Achievement

Before starting the research we assumed there was no major difference among the students in the four schools. This was tested using the Analysis of Variance (ANOVA) procedure, with the student pre-test score as the dependent variable (DV) and the schools

as the independent variable (IV). The four schools and their mean test scores were: Kiyan with 91 students ($M = 7.64$ $SD = 3.23$), Shisong with 45 students ($M = 6.99$ $SD = 3.12$), St. Francis with 45 students ($M = 7.76$ $SD = 2.80$) and St. Peters with 49 students ($M = 7.84$ $SD = 3.16$). No significant differences were observed on the ANOVA procedure $F(3,226)=0.71$, $p=.55$). The $p = 0.05$ critical value was applied.

The ANOVA procedure was then applied on the gain scores, that is, the difference between the mean gains of the pre-test and the post-test results among the four schools: Kiyan ($M = 1.53$ $SD = 3.49$), Shisong ($M = 1.08$ $SD = 3.66$), St. Francis ($M = 1.07$ $SD = 2.67$) and St. Peters ($M = 2.41$ $SD = 1.72$). The findings ($F(3,65)=0.47$, $p=.70$) indicated no statistical difference between the schools. The null hypothesis was therefore accepted. There were no differences found between the control and experimental groups.

The gains data were further examined by looking at the data from the schools in more detail. The analysis compared the combined data for the two experimental schools and the two control schools. The distributions show different patterns. The distribution of the experimental schools seen in Figure 4.1 is skewed to the left indicating higher math gain compared to Figure 4.2 (The Distribution Plot for St. Francis and St. Peters). The experimental schools also showed a more systematic shift.

Figure 4.1: Distribution Plot for Experimental Schools (GHS Shisong and GHS Kiyan)

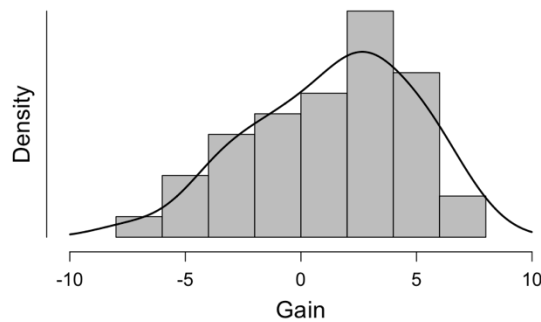
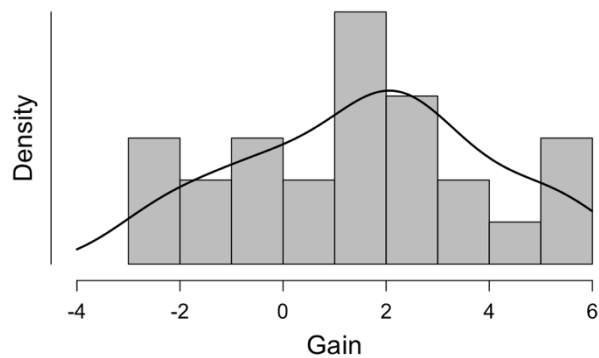


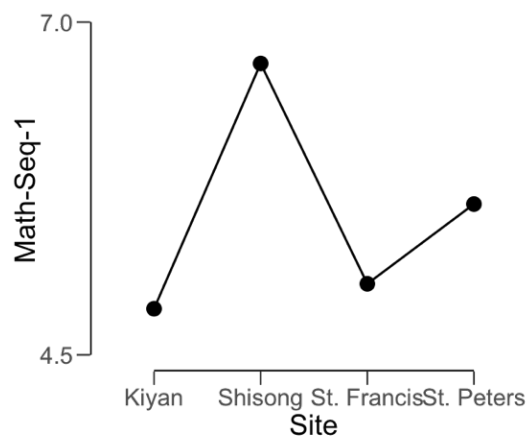
Figure 4. 2 Distribution Plot for Control Schools (St. Peters and St. Francis)



There is good reason to believe that the student test scores discussed above were adversely affected by the teacher strike and the resulting disruptions. Thus, further analysis was conducted on data from the Math Test Sequence One, which was given one month after implementation began, and before the unrest. Using a $p=.05$ criterion for statistical significance, an ANOVA for the math sequence one test results among the four schools: Kiyan ($M = 4.85$ $SD = 2.54$), Shisong ($M = 6.69$ $SD = 3.78$), St. Francis ($M =$

5.03 $SD = 2.76$) and St. Peters ($M = 5.63$ $SD = 2.93$) showed that ($F(3,226)=4.28$, $p=.006$) there was a statistical difference among schools. To investigate this finding further, we ran a post-hoc Tukey test at a $p=.05$. The post-hoc comparison revealed that significant differences occurred between students from the two experimental groups Kiyan and Shisong ($p=0.004$). According to the descriptive statistics for the Math Sequence One Test the students from Shisong ($M=6.69$ $SD = 3.78$), which is the school I taught, scored higher than the students from the other three schools: Kiyan, St. Francis and St. Peters. Figure 4.3 is a plot of the average scores for each of the schools.

Figure 4. 3 Math Sequence One scores per school



Influencing factors

English Literacy

We also wanted to see if there is any relationship between literacy levels and possible effects in the students' achievement. We gave an English literacy test to measure the reading comprehension level of the students. The null hypothesis stated that there was no relationship between English literacy and students' mathematical achievement

and the alternative hypothesis stated that there was a relationship between English literacy and mathematical achievement. The results of the Pearson correlation analysis revealed that there was no significant relation between Literacy and Math Gain ($r=-0.07$, $p=0.59$). This means that we can accept the null hypothesis because it seems that reading comprehension levels did not influence mathematical achievement. The same results were obtained when comparing the Literacy test scores with the Math Sequence One scores ($r=0.14$, $p=0.25$).

Math Literacy

We also ran a test to measure the math literacy level of the students. For this test the null hypothesis stated that there is no relationship between math literacy and students' mathematical achievement and the alternative hypothesis stated that there was a relationship between Math Literacy and students' mathematical achievement. The results of the Pearson correlation analysis revealed that there was a positive correlation between Math Literacy and the math pre-test ($r=0.39$, $p<0.001$). A positive correlation was also found between Mathematical Literacy test scores with the Post Test scores ($r=0.33$, $p=0.006$). Using the Math Sequence One test data, there was a positive correlation between Math Literacy and Math Sequence One Scores ($r=0.49$, $p<0.001$). This means that we can reject the null hypothesis because mathematical literacy levels are positively correlated to mathematical achievement.

Interest in Math

We wanted to see if there was any relationship between interest in mathematics and the students' achievement. The null hypothesis stated that there is no relationship between interest in math and mathematical achievement and alternative hypothesis stated that there was a relationship between interest in math and mathematical achievement. The results of the Pearson correlation analysis revealed that there was a positive correlation between Math Interest and the Math Gain ($r=0.27$, $p=0.03$). This means that we can reject the null hypothesis because there is a significant positive correlation between students' achievement and their interest in mathematics.

Study Habits

As part of the Likert questionnaire, we asked 69 students among the four schools: Kiyan ($M=4.13$, $SD=1.15$), Shisong ($M=3.75$, $SD=1.13$), St. Francis ($M=3.33$, $SD=1.11$) and St. Peters ($M=3.46$, $SD=0.93$) if they studied for math at least three times a week, by choosing from strongly agree to strongly disagree to indicate how they feel about the argument given. We wanted to know if there was any relationship between study habits and the students' achievement. The null hypothesis stated that there is no relationship between study habits in math and mathematical achievement, while the alternative hypothesis stated that there is a relationship between study habits in math and mathematical achievement. The results of the Pearson correlation analysis revealed that there was a positive correlation between study habits and the math post-test ($r=0.33$, $p=0.005$). This means that we can reject the null hypothesis because there is a significant positive correlation between students' achievement and their study habits in mathematics.

Home Background

We asked the students with whom they were staying with during the academic year. From the 66 students that took the questionnaire we found that 11.6 % stayed in school, 65.2% stayed with one or both parents, and 23.2% stayed with another family member. We wanted to see if there was any correlation between who the students stayed with and the mathematical achievement. We ran an ANOVA with home background (IV), and Math Gain (DV). Using a $p=.05$ criterion for statistical significance, an ANOVA between Math Gain ($M=1.49$, $SD = 3.11$) and Home background showed that ($F(2,66)=0.01$, $p=0.99$) the relationship between Math Gain and Home background is non-significant. The same results were obtained when comparing Math Sequence One scores ($M=5.41$, $SD = 3.01$) with Home Background ($F(2,66)=0.07$, $p=0.93$).

Owning the Cameroonian math textbook

We also wanted to know if owning the Cameroonian textbook would influence students' achievement. We found that in the control group only 30.77% of the students own the book and in the experimental schools 32.56% owns the Cameroonian math textbook. A one-way analysis of variance showed that owning the Cameroonian textbook was non-significant to Math Gain ($F(1,67)=0.48$, $p=0.49$). Similar results were achieved when comparing owning the math textbook with the scores of Math Sequence One test ($F(1,67)=1.83$, $p=0.18$).

Teacher Effect

All teachers mentioned that they prepared a lesson plan before coming to class. The teachers also mentioned that they tried to do group work in the classroom, except for the teacher in Kiyan, who found it challenging due to the number (91) of students in his classroom. A pattern observed in the questionnaire responses is that all the teachers faced the challenge of low literacy levels among the students and the lack of textbooks. The teacher from Kiyan mentioned having problems with classroom management but the other teachers didn't mention that as a challenge. From the questionnaires responses it seems that the two teachers from the control group were implementing the CBA in their classrooms, making their lessons somehow interactive and relatable to real life.

Discussion

The main purpose of the study was to investigate how applying student-centered techniques affect students' mathematical achievement and what other factors might influence our results. The results of our study showed that achievement in mathematics is affected and has a positive correlation with various factors including teaching techniques, math literacy, students' interest and study habits; achievement was not found to be related to English literacy, home background and owning the Cameroonian textbook. In this section, we will discuss our results and how the results are connected to some limitations of our study.

Before discussing the results, it is important to present some of the challenges observed during the duration of the study. The main challenge that impacted our results was the closing of the schools for a whole year due to the Anglophone strike. This means

that our intervention only lasted the first trimester from September to November. This caused an enormous attrition of participants. We started with 230 Form 2 math students and ended with 69 Form 2 math students. This means that we were able to administer the pre-test and the Math Sequence One test to 230 students, but the post-test along with the questionnaire was only administered to 69 students. The post-test, the literacy test and the questionnaire were administered a year after no school attendance since the schools were closed. Not all of the students returned to the school because they dropped out or changed schools to the Francophone region to be able to continue their studies. This causes that the sample size after the strike might be insufficient to allow us to draw strong conclusion.

Another limitation from our study is the inherit difference between private and public schools. Research from Nsubuga (2015) and Savas, Tas & Duru (2010) suggests that students in private schools tend to perform better and have higher achievement than students in public schools. Even though the analysis of our pre-test didn't show any significance difference among the four schools, it is necessary to mention that the difference in resources among the four schools was considerable. The control group schools, St. Peters and St. Francis, are both private Catholic schools with more resources compared to the government schools Shisong and Kiyan. Another difference is the number of students per classroom. Among the four schools, Kiyan had the biggest number of participating students ($N=91$) and the teacher mentioned having difficulties with classroom management due to the high number of students and the inability to do group work.

After mentioning some of the limitations from our study, let us discuss our findings. For the main research question in our study—Will the Form 2 math students in the schools using student-centered techniques perform better than the Form 2 math students in the schools using teacher-centered techniques? —we were trying to determine whether the experimental schools (Shisong and Kiyan) would have a higher mathematical achievement due to the use of the book *Math: One More Story*. The statistical analysis for Math Gain didn't show any significant difference among students' achievement from the control and experimental schools, but the graphs tell us a deeper story. When we look at Figure 4.1: *Distribution plot for the experimental schools* we can see it is skewed to the left, which shows the experimental schools had a greater achievement. On the other hand, for Math Sequence, we have a significant difference among schools. After running Post hoc analysis, the main difference was found to be between the two experimental schools, GHS Shisong and GHS Kiyan. In the case of Math Gain the small sample size might be affecting the results since it might not be enough information to draw conclusions. The difference in the math sequence one test scores might be due to the difficulties the teacher from Kiyan was experiencing with the large class size. Another reason for this might be the teacher effect. We expected the control groups to use the traditional teacher-centered techniques, but it is possible that they were also implementing some student-centered activities in their own ways. All four schools showed an improvement in mathematical achievement and according to the teacher surveys all of them were using student-centered techniques meaning that our findings coincide with Fuller (1987), Grouws (2000) and AIMS (2018), that applying well-defined student-centered techniques increases students' mathematical achievement.

Our study shows that there was no significant relationship among English literacy and math achievement. This contradicts the findings of Gugleml (2012) and Nizoloman (2013) where they argue reading comprehension is related to math achievement. Our small sample size might not be enough to draw a final conclusion saying that reading comprehension is not related to math achievement. Another reason for these results might be attributed to the literacy test. The test is mostly done with primary school children and it might not be comprehensive enough for the Form 2 students.

For the relation between math achievement and math literacy, our study extended the findings from Rutherford and Vanderwood (2009) and Nizoloman (2013) when it showed that math literacy or numeracy is positively correlated to math achievement in all the math tests taken by the students.

There was also a positive correlation between students' interest and math achievement. This expands the research from Nsubuga (2015) and Ngenche (2017) where they found that students' attitude and interest is correlated to math achievement. The higher the interest in math, the higher the math achievement will be.

The results for study habits agreed with the research conducted by Dickerson et al. (2015) and Fuller (1987). Study habits or amount of math homework done by the students had a positive correlation with the post-test results. This means that the more days a week the students dedicated to studying math the higher their achievement was.

Home background or with whom the student was living during the school year was not correlated to math achievement. Our results challenge the research done by Dickerson and Cooksey (1981), since these two researchers found a relationship between

whom the students lived with and their math achievement. These results could be influenced by the small sample that answered the questionnaire, since it was done after the strike. A limitation of the home background study is that socioeconomic factors were not included in the questionnaire. For a future study it will also be of value to ask the education level of the parents and with how many people the students are staying with. In other words the question of who the students live with might not be enough to draw a correlation test between home background and math achievement.

Our results showed that owning the Cameroonian textbook was also not correlated with math achievement. This challenges the literature since Dickerson et al. (2015) argue that having the math textbook increases achievement. It is likely that the students could have lied in the survey out of embarrassment. Sometimes the students say they have the book to avoid being punished by the teachers or the school administration. If they have the book, is an outdated version of the book. For the study we still used the math textbook prescribed by the government with the experimental schools because it is mandatory by the school administration. The math textbook was mostly used to assign homework to the students. The fact that owning the Cameroonians math textbook allows the argument that if the teacher is using the book *Math: One More Story* the students don't need to have the math textbook prescribed by the government, because the lesson plans come with handouts for the students. If the teacher offers good notes and practice problems, mathematical achievement can increase without needing the math textbook.

The influence of the teacher effect might be bigger than anticipated. It is arguable that having the researcher as one of the teachers is both a strength and a weakness.

Shisong, the school I was teaching at outperformed the other three schools. I was using the book *Math: One More Story* but there are also other factors influencing my teaching abilities. Some of the factors are that I had fewer students in my classroom than Kiyan the other experimental school, I also had good rapport with the students, and I had specific classroom management techniques and high expectations for my students. Also my teacher training background might also influence the successful use of the student-centered techniques in my classroom. My teacher training was based on practice of these specific student-centered techniques, while most of the Cameroonian teacher training is based on pedagogy and theory.

Chapter 5: Conclusions and Recommendations

This study was conducted in the North West region of Cameroon with four participating schools to study the effects of student-centered techniques and other factors related to students' math achievement. Even though the two control schools were private and the two experimental groups were public, the comparison between pre-test showed no significant difference among school.

Based on the results of this study the difference between math gain between the pre-test and the post-test taken 17 months after the pre-test were not significant. The prolonged time gap between the pre-test and the post-test was caused by the closing of the schools due to the strike in the Anglophone regions. There were other external factors that might have accounted for the non-significant difference between the tests. There is reason to believe that the student math gain was adversely affected by the teacher strike and the resulting disruptions. The difference in sample size between the pre-test and the post-test could explain the non-significant difference among schools.

When the math gains data from the schools were examined further the experimental schools showed a more systematic shift in achievement compared to the control schools. The experimental schools have a higher variety of results including higher achievement than the control groups. Again these results are affected by the difference in sample size and the disruptions from the strike. It is worth mentioning that the teacher effect is another factor influencing the results. The implications and difference between the teacher trainings in Cameroon versus the United States might affect the ability to implement the student-centered techniques with confidence.

The results of the Math Test Sequence One, which was given one month after implementation began, and before the unrest prove to be significantly different. When the post-hoc analysis was ran the main difference was between the two experimental schools. The highest performing school was Shisong, which is the school I was teaching at. These results, while surprising, might be explained by the teacher effect and difference of classroom environment. If both the teacher in Kiyan and I were using the student-centered techniques from the book *Math: One More Story*, so how is it that the students performed so differently? The math teacher from Kiyan mentioned having trouble implementing some of the student-centered techniques due to the large amount of students in class and having to spend too much time addressing students' behavior in class. In Figure 4.3 we can see the plot for the scores of the Math Test Sequence One for each school. It is possible that the students in Shisong had the highest performance because I followed the lesson plans from the book *Math: One More Story* and had less number of students in my class, good rapport with them, specific classroom management interventions and more practice implementing student-centered techniques due to my teacher training background.

For the other variables the study shows that math literacy, interest in math and study habits are related to math achievement. On the other hand, our data analysis didn't show that English literacy, home background and owning the Cameroonian math textbook are related to achievement.

Some of our results expanded the current literature. For example, we agree with the research from Rutherford and Vanderwood (2009) and Nizoloman (2013) in that math

literacy is positively correlated to math achievement. The research from Nsubuga (2015) supports our finding on how students' attitude and interest is correlated to math achievement. Study habits or amount of math homework done by the students had a positive correlation with the post-test results, which agrees with Dickerson et al. (2015) and Fuller (1987).

Some of our findings differ with the literature. For example, our study showed that there was no significant relationship between English literacy and math achievement. This contradicts the findings of Gugleml (2012) and Nizoloman (2013), where they argue that reading comprehension is related to math achievement. Our small sample size might not be enough to draw a final conclusion saying that reading comprehension is not related to math achievement.

We faced many challenges while carrying out this study. The biggest challenge was not been able to collect data for a full academic year due to the strike and the closing of the schools. Also the two control schools were private schools, which means they might have more resources than the other two public schools.

The goal of this study was to provide teachers with a concrete tool with student-centered techniques that would transform the teaching strategies of future Peace Corps volunteers and Cameroonian teachers to permit a better performance of Cameroonian students. It is also believed that this research will serve as an example on how to incorporate what the Cameroonian government wants which is the *Competency Based Approach* (CBA) in class, allowing the Cameroonian Education System to move from theory based to a practical based. The book *Math: One More Story* in conjunction with

the recommended CBA approach, are the perfect match to implement more student-centered techniques in the classroom. The hope is that the book *Math: One More Story* is replicated in other subjects to guide teachers on how to integrate literacy in content areas using student-centered techniques to increase students' interest and academic performance.

In general after doing this study my recommendations to increase student achievement in mathematics can be summarized as follows:

1. Focus on math literacy (numeracy) throughout primary and secondary schools. It is proven that achievement is strongly related to numeracy and how you can apply the math literacy to solving problems (Nizoloman, 2013; Rutherford & Vanderwood, 2009).
2. Increase students' interest in mathematics by bringing real world examples and making sure the students are not missing too much material due to absences. Interest in math and students' attitude is positively related to math achievement (Guglielmi et al., 2015; Ngeche, 2017; Savas et al., 2010).
3. Assign homework or practice problems so the learning of mathematics is not limited to the four periods of class a week. Besides assigning homework, it is recommended to correct the homework for the benefit of the students. Especially in public schools the number of hours spent studying for the subject increases the achievement in class (Dickerson et al, 2015; Fuller, 1987; Ntondumu, 2010).

4. Implement student-centered techniques in the shape of group work or hands on activities to encourage participation of students in class. Student-centered techniques in the shape of group work, class discussions and hands on activities increases students interest and participation in class directly increasing the students overall achievement (AIMS, 2018).

For future work, we would suggest to do the study under more stable circumstances in order to assess the impact of long-term implementation. The external factors make it harder to assess the impact. However, the data from the short-term assessments are promising. Other suggestions for future work are more reliable instruments of assessment, a way to control teacher effect by making all the participating teachers have the same training, analyze other variables like the difference between public and private school and get the lesson plans from the control schools, since the experimental schools are using the lesson plans from the book *Math: One More Story*. Another suggestion is to measure teacher effect is to add more questions to the teacher survey and do recorded peer observations for later analysis. Due to the collaborative nature of the study the teachers in Cameroon will continue to explore the implications of using student-centered techniques in math achievement by taking these recommendations under consideration.

References

- Akoko, M. (2010). Assessment of the Effects of Affective Student Characteristics and Educational Background on Mathematics Achievement at the Level of Higher Education in Cameroon. *Grin Verlag*. Retrieved from <https://www.grin.com/document/172999>.
- Ale, S.F. (2001): Poor Performances in School Mathematics. Students' Views on Causes and Remedies. *Educational Studies*.
- Bipoupout, J. (2007). The contribution of the competency-based approach to education for all in Cameroon. *Prospects*, 37(2), 205-221.
- CAMEDUS (2016). Cameroon Educational System. Retrieved May 27, 2018, from http://camedus.com/index.php?route=pages&menu_id=18&level1_menu_id=106
- Cameroon. (2017, April 12). Retrieved January 25, 2018, from <http://uis.unesco.org/en/country/CM>
- Cameroon - Percentage of repeaters in lower secondary general education, all grades, male. (2014). Retrieved January 28, 2018, from <https://tradingeconomics.com/cameroon/percentage-of-repeaters-in-lower-secondary-general-education-all-grades-male-percent-wb-data.html>
- Cameroon independence protests result in deaths. (2017, October 2). *BBC News*. Retrieved January 24, 2018, from <http://www.bbc.com/news/world-africa-41461007>
- Cooksey, Brian. (1981). Social Class and Academic Performance: A Cameroon Case Study. *Comparative Education Review*, 25(3), 403-18.
- Dickerson, McIntosh, & Valente. (2015). Do the maths: An analysis of the gender gap in mathematics in Africa. *Economics of Education Review*, 46(C), 1-22.
- Echu, G. (2004). The Language Question in Cameroon. *Linguistik Online*, 18(1), 19-33.

Education and Policy Data Center. (2012). Cameroon. Retrieved May 27, 2018, from <https://www.epdc.org/country/cameroon>

Education-Cameroon: Teachers Give School System a Failing Grade. (2005, June 09). *Africa News Service*, p. Africa News Service, June 9, 2005.

Ekrem Savaş, Selma Taş, & Adem Duru. (2010). Factors Affecting Students' Achievement in Mathematics *. *Journal of Inonu University Faculty of Education*, 11(1), 113-132.

Grouws, D., Cebulla, Kristin J, & ERIC Clearinghouse for Science, Mathematics, Environmental Education. (2000). *Improving student achievement in mathematics* (ERIC digest (ERIC Clearinghouse for Science, Mathematics, and Environmental Education) ; EDO-SE-2000-09). Columbus, Ohio]: ERIC Clearinghouse for Science, Mathematics, and Environmental Education.

Guglielmi, R. S. (2012). Math and science achievement in English language students: Multivariate latent growth modeling of predictors, mediators, and moderators. *Journal of Educational Psychology*, 104(3), 580-602.
doi:<http://services.lib.mtu.edu:2080/10.1037/a0027378>

Kiwanuka, Henry Nsubuga, Van Damme, Jan, Van Den Noortgate, Wim, Anumendem, Dickson Nkafu, & Namusisi, Speranza. (2015). Factors Affecting Mathematics Achievement of First-Year Secondary School Students in Central Uganda. *South African Journal of Education*, 35(3), 63-73.

Korau, Y. K. (2006). A Systematic Attempt to Establish the Fear and Poor Performance of Senior Secondary School Students in Geometry and Trigonometric Concepts. A Case Study of WAEC Candidates. A Paper Presented at the 43rd Annual Conference of Mathematical Association of Nigeria Held at A.T.B.U. Bauchi.

Lamm, B., Keller, H., Teiser, J., Gudi, H., Yovsi, R., Freitag, C., Lohaus, A. (2017). Waiting for the Second Treat: Developing Culture-Specific Modes of Self-Regulation. *Child Development*, Child Development, 06/06/2017.

- Mariana Ngeche, T. N. (2017). Student and Teacher Attitudes as Correlates of Performance in Mathematics in Cameroon Secondary Schools. *International Journal of Humanities Social Sciences and Education*, 4(12), 1-10. Retrieved June 1, 2018, from <https://www.arcjournals.org/pdfs/ijhsse/v4-i12/1.pdf>. doi: <http://dx.doi.org/10.20431/2349-0381.0412001>
- Ndifor, R. (2014, April 12). Introduction of CBA Cameroon. Retrieved January 23, 2018, from <https://ndiforroseline.wordpress.com/2014/04/12/introduction-of-cba-in-cameroon/>
- Nizoloman, O. (2013). Relationship between Mathematical Ability and Achievement in Mathematics among Female Secondary School Students in Bayelsa State Nigeria. *Procedia - Social and Behavioral Sciences*, 106, 2230-2240.
- Nkwetisama, C. M. (2012). The Competency Based Approach to English Language Education and the Walls between the Classroom and the Society in Cameroon: Pulling Down the Walls. *Theory and Practice in Language Studies*, 2(3). doi:10.4304/tpls.2.3.516-523
- Nsamenang, & Lamb. (1995). The force of beliefs: How the parental values of the Nso of Northwest Cameroon shape children's progress toward adult models. *Journal of Applied Developmental Psychology*, 16(4), 613-627.
- Ntondumu, B. (2010). Determinants of student achievement a comparative study of the case of a mission, public and private school in cameroon. *University of Oslo*, 1-88. Retrieved June 15, 2018, from <https://www.duo.uio.no/bitstream/handle/10852/30469/Thesisx2.pdf?sequence=>.
- Odunnuga, J. B. (2007). Understanding Primary Mathematics Methods and Curriculum. Satellite Publication, Abeukouta, Nigeria.
- Oxford Learning. (2010, May 05). What does Math Literacy Mean? Retrieved May 22, 2018, from <https://www.oxfordlearning.com/what-does-math-literacy-mean/>
- PNDP. (2011, June 09). *Kumbo Council Development Plan* (Republic of Cameroon, Kumbo Council). Retrieved May 30, 2018, from http://www.pndp.org/documents/20_CDP_Kumbo.pdf
- Rutherford-Becker, Kristy J., & Vanderwood, Michael L. (2009). Evaluation of the Relationship between Literacy and Mathematics Skills as Assessed by Curriculum-Based Measures. *California School Psychologist*, 14, 23-34.

- Short, D. J., Vogt, M., & Echevarría, J. (2011). *The SIOP model for teaching science to English students*. Boston: Pearson Education.
- Tella, Adedeji. (2007). The Impact of Motivation on Student's Academic Achievement and Learning Outcomes in Mathematics among Secondary School Students in Nigeria. *EURASIA Journal of Mathematics, Science & Technology Education*, 3(2), 149-156.
- Vagvolgyi, ReKa, Coldea, Andra, Dresler, Thomas, Schrader, Josef, & Nuerk, Hans-Christoph. (2016). A Review about Functional Illiteracy: Definition, Cognitive, Linguistic, and Numerical Aspects. *Frontiers in Psychology*, 7, <xocs:firstpage xmlns:xocs=""/>.
- World Bank. (2014). Cameroon Region: Sub-Saharan Africa. Retrieved January 28, 2018, from https://www.epdc.org/sites/default/files/documents/EPDC%20NEP_Cameroon.pdf

Appendix A: Math Pre and Post Test

Name: _____ Date: _____ School: _____

1. Solve each fraction

a. $\frac{2}{5} + \frac{1}{4}$

b. $\frac{7}{9} - \frac{2}{3}$

c. $\frac{3}{5} \times \frac{2}{9}$

2. Solve

a. $(99-11)-(41)$

b. $5 \times 3 - 4$

c. $3 \times (8-5)$

d. -4×-5

e. $-12 \div 4$

3. Graph in the Cartesian plane the points (-3, 4) and (2, 1).

4. Solve

a. 5^3

b. 2^{-4}

c. 9^0

5. Convert this fraction into decimal

a. $\frac{7}{100}$

b. $\frac{1}{5}$

6. True or False

_____ a. $36 > -15$

_____ b. $-27 > 1$

_____ c. $18 < -3$

_____ d. $20 = -20$

_____ e. If we add all the angles in a triangle the result will always be 180 degree.

_____ f. In an isosceles triangle all sides are equal.

Appendix B: Math Sequence One Test

Name: _____ Date: _____ School: _____

I. Draw a number line going from -5 to 5 and circle the natural numbers. (1 mark)

II. Evaluate each problem (2 marks)

a) 5^{-3}

b) 27^0

c) 3^4

d) $\frac{1}{3^{-2}}$

III. Fill in the blanks (1 mark)

a) When you multiply two equal bases the powers _____ each other.

b) When you divide two equal powers the powers _____ each other.

IV. Solve using the laws of indices (5 marks)

a) $x^2 \times x^4$

b) $p^5 \div p^3$

c) $(y^2)^3$

d) $(2x^3)^3$

e) $\frac{5m^2 \times 4m^3}{2m^4}$

V. Find the pattern: (1.5 marks)

- a) What two numbers come after? 1, 3, 6, 10, 15, _____, _____
b) What are you doing each time to find the new number?

VI. Fill in the blanks (1 mark)

- a) When we cube a number we multiply the number _____ times by itself.
b) When we square a number we raised the number to the _____ power.

VII. Solve each problem (3 marks)

- a) $\sqrt{49}$ d) $\sqrt[3]{81}$
b) $\sqrt{16}$ e) $\sqrt[3]{125}$
c) $\sqrt{144}$ f) $\sqrt[3]{27}$

VIII. Solve each fraction (2.5 marks)

- a) $\frac{5}{6} + \frac{2}{3}$ d) $\frac{6}{11} \times \frac{-5}{2}$
b) $\frac{7}{10} - \frac{1}{4}$ e) $\frac{4}{9} \div \frac{2}{3}$
c) $\frac{3}{7} + \frac{4}{7}$

IX. Change to two decimal places (1.5 marks)

- a) $\frac{21}{5}$
b) $\frac{6}{14}$
c) $\frac{32}{100}$

X. Round each number to the place given (1.5 marks)

- a) 318.28 (*whole number*) =
b) 3.143 (*tenth place*) =
c) 0.657 (*hundredth place*) =

Appendix C: Literacy Test

Literacy Pre-Test for Math in Cameroon

Story

Yesterday, Claire lost her pullover. She was worried. She looked under her bench and inside her bag. She ran outside and looked under the big tree. It was not there. She told her teacher she had lost her pullover. The teacher pointed at Claire's neck. Claire laughed.

Comprehension

1. When did this story take place?
2. What did Claire lose?
3. Where did Claire look for her pullover?
4. Where was Claire's pullover?
5. Why did Claire laugh?

Symbols

1,326



÷



Math Literacy

$$n > 7$$

$$\frac{1}{10}$$

$$(a)(b)$$

$$x^2$$

$$3 - n$$

$$-1$$

Instructions: Learners have one minute to read the story aloud. Follow along write any incorrect words with a slash in a separate paper. Count self-corrections words as correct. Stay quiet, unless the students hesitate for 3 seconds, in which case provide the word, point to the next word and say "Please go on." At the end of the 1-minute write down the final word read. When 1 minute is up or if the student finishes reading the passage in less than 1 minute, REMOVE the passage from in front of the student, and ask the comprehension question. Give the learner at most 15 seconds to answer the question, mark the child's response, and move to the next question. Follow to ask the Symbols and Math Literacy Questions.

Appendix D: Student Questionnaire

1. Age: _____
2. Gender: Female/ Male
3. Do you have the math textbook? Yes/No
4. Who do you live with?

In questions 5 to 11 answer using a scale that goes from *strongly agree* to *strongly disagree*.

		Strongly Agree	Agree	Neutral	Disagree	Strongly Agree
5	I enjoy Form 2 math class					
6	Math in Form 2 makes me happy					
7	I enjoy doing math					
8	In Form 2, I study for math at least three days a week					
9	I have passing marks in math Form 2					
10	Math was interesting in Form 1					
11	I had passing marks in math Form 1					

Appendix E: Teacher Questionnaire

1. School: _____
2. How many students you have in your Form 2 class? _____
3. Do you lesson plan?
4. Do you do group work in your math Form 2 class?
5. Describe your typical math lesson.
6. What materials you bring to class?
7. What ways you teach vocabulary?
8. What student-centered techniques you use in your classroom?
9. Can you incorporate literacy in your math class? In what ways do you do it?
10. What challenges do you face in the classroom?

Appendix F: Copyright documentation

Figure 1.1 Map of Cameroon. License under The Guardian. Image source: <https://www.theguardian.com/global-development/2018/may/30/cameroon-killings-escalate-anglophone-crisis> See Appendix F for full attribution and copyright licensing information. Accessed June 2018.