**UNIVERSITY OF EDUCATION, WINNEBA**
**FACULTY OF SCIENCE EDUCATION**
**DEPARTMENT OF MATHEMATICS**

# EFFECTS OF COLLABORATIVE LEARNING AND MATHEMATICS ACHIEVEMENT ON GENDER GROUPINGS OF COLLEGES OF EDUCATION IN GHANA

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**of the requirement for the award of degree of Master of Philosophy (Mathematics Education) in the University of Education, Winneba**

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# DECLARATION

## STUDENT'S DECLARATION

I, **Collins Fordjour Nkrumah** hereby declare that this thesis is the result of my own original research work and that no part of it has been presented for another degree to the University of Education, Winneba or elsewhere and also, all those literatures sought in this work had been duly acknowledged.

Signature…….....

Date……....

## SUPERVISOR'S DECLARATION

I hereby declare that the preparation and presentation of this thesis was supervised in accordance with the guidelines of supervision of thesis laid down by the University of Education, Winneba.

Supervisor's name: **PROFESSOR S. K ASIEDU-ADDO**

Signature…….……

Date……..…

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# DEDICATION

I dedicate this thesis to the Almighty God.

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# ABSTRACT

The study was conducted to find the effects of collaborative learning on gender groupings in the mathematics performance of Bachelor of Education (BED) students at the Colleges of Education in Ghana. The design for the study was experimental design, comprising 144 Mathematics students purposively selected from all Science and Mathematics colleges in Ashanti and Brong Ahafo regions of Ghana. The quantitative data comprised questionnaire and test. The study variables were students who had been admitted into the colleges at the two regions purely for Mathematics and Science programs. The variables in this study comprised 9 groups: three all-male groups, three all-female groups, and three mixed groups. The instrument is composed of 20 questions covering the content area and testing the various levels of knowledge, understanding and application. Simple means, standard deviation and variance were used to answer research questions while, Analysis of variance (ANOVA) was utilized for the testing of the hypotheses. The results indicated that students' formative tests mean scores had no significant difference which implies that if students were working alone, they might obtain more or less similar results. The collaborative learning treatment, where the students worked in different gender groups, showed that there was a significant difference in their performance. Specifically, all-female groups obtained the highest mean score followed by mixed groups. In the mathematics achievement test, the results revealed that all male group performed better than the other two groups. The study recommended that tutors of mathematics in the Colleges of Education use collaborative learning in their various classrooms.

# CHAPTER ONE

# INTRODUCTION

## 1.1.0 Overview

This chapter provides an introduction to the research study. The introduction includes the background of the study, statement of the problem, the purpose of the study, objectives and research questions which guided the study. It further highlights the significance of the study, the delimitations and organization of the study.

## 1.1.1 Background to the Study

In Ghana, mathematics is compulsory for all Basic and Senior High School students. However, the effect of compulsion on students' interest has not been explored. The interaction between compulsion, future career influence and students' interest lacks the exploration and explanation. Studies in mathematics have showed that students show low interest in the subject for lack of motivation and involvement (Asiedu-Addo, Assuah, Yakubu and Yarhands, 2016).

For some years now, Mathematics has been an area of application in several fields. Colleges of Education students in year 1 needed to pass their first-year semesters 1 and semester 2 Mathematics examinations before they could progress to year two. This makes mathematics at the Colleges of Education in Ghana a compulsory subject to the students in year 1. Apart from the compulsory nature of the mathematics, the colleges have been affiliated to different public universities in Ghana with different beliefs, expectations, goals and programs.

Again, the colleges have been grouped based on various programs of study with the colleges own mission and vision different from the affiliate universities. Apart from all these challenges, the colleges also go through selection of students into different

programs. Some of these programs are General Science and Mathematics, French, Physical Education, Social Studies and Vocational and Technical Education, Agriculture Science, Music and Dance.

It must be noted that, some of the colleges are purely all male students, all female grouping and mixed groupings in Ghana. These three categories became the focus of this study. The development of learning in small groups in higher education has occurred, in part, because of strong beliefs by some scholars that indicates that students working in small groups outperform their counterparts who work individually in a number of key areas. These include knowledge development, thinking skills, social skills, and course satisfaction (Davidson, 2014).

Globally, education is used as an instrument par excellence to modify human behaviour(s) and produce functional individuals that would contribute towards the economic development of the larger society. This makes human society to be characterized by economic dynamism that requires people to develop competence in applying mathematics education principles to manage its complexities.

This development is a reawakening stimulus on the desire for academic institution such as universities, colleges of education and other stakeholders to seek to structurally reengineer mathematics education to overcome the mathematics challenges of the new millennium (Tsamenyi & Onumah, 2010) . However, some institutions have failed in this perspective (Nlemadim, 2016). reported that currently mathematics education as a model has failed to focus on developing graduates for successful career worldwide. Whereas, mathematics education should enable students to possess the necessary skills for work place. These made this study imperative. Therefore, this study investigated effects of collaborative learning on students'

mathematics achievements in colleges of education in Ghana; while considering the moderating influence of gender.

Success in Basic Algebra needs students to develop intellectual skills such as problem solving and critical thinking. Intellectual skills include the ability to relate concepts learned to new situations, the ability to think for oneself, to critically assess new information and situations, and to apply knowledge from one workplace context or problem to another.

Awayiga and Tsamenyi (2010) asserted that intellectual skills help mathematicians to: a) exercise judgment based on comprehension of an unfocused set of facts; and b) display a capability for inductive-thought process and apply value-based reasoning in unfamiliar setting. And these are the core principles in Basic Algebra which applications could enhance competence in understanding and applying knowledge of problem solving and critical thinking skills. Competence in Basic Algebra requires students to develop their conceptual and analytical skills. Students could best develop these skills, when they learn from each other, be emotionally stable to accommodate other people's point of view, be objective in criticism and constructive in synthesizing ideas.

This however, implies adopting a new paradigm to teaching and learning; such as encouraging students to develop collaborative and emotional intelligence skills that would enable students tolerate each other's adequacy and inadequacies and learn effectively. Atkins (2010) affirmed that advocates of collaborative learning technique assumed that students learn better from each other and that the teacher is not the only source of information in the classroom

Powell and Kalina (2009) reported that through collaborative learning, students have regular opportunities to communicate and interact socially and intellectually. These are critical experiences in the classroom as Atkins (2010) argued that effective communication and collaboration are essential to becoming successful learners. Students learn best when engaged in activities that reflect their interests and experiences.

Collaborative learning is a highly structured form of group work that focuses on problem solving, investigation, critical thinking and independent study that can lead students to a successful mathematics learning when directed effectively by the mathematics teacher. Students in collaborative learning also gain deeper learning and genuine paradigm shifts in their thinking and ability to develop positive interdependence and individual accountability (Mills, 2009).

Literature has documented results regarding the effects of collaborative learning pedagogy which enhances learners' ability to solve problems that require analysis of the subject matter (Hwang & Tong, 2008). Collaborative learning is an appropriate teaching method to meet the needs for developing stronger interpersonal friendships which in turn lead to higher interaction and communication among learners. Researchers contended that the application of emotional intelligence by learners helps attain intellectual stability, ability to interpret and conceptualize meaning (Allinson and Hayes, 2012). It also allows students to communicate and listen effectively which are characteristics that could stimulate managerial competence among Basic Algebra students in the colleges of education in Ghana. According to psychological literature, scientists have found a strong relationship between gender and academic performance.

In addition, behavioral skills such as flexibility, independence, creativity, and interpersonal skills that give individual's the ability to listen, present views, transfer knowledge, negotiate and collaborate, were deemed of equal importance. These latter skills provided the basis of what has become known as emotional intelligence. Thus, emotional intelligence is considered to be an intangible asset in determining the difference between individual performance and performance as a team player (Ajax & Akhilesh, 2007).

For college students to become good team players, educators need to provide students with the opportunities to understand and develop the skills that they will require to succeed in the working environment. Again, college mathematics tutors have the responsibility to provide their trainees with a strong foundation in both technical and emotional training so that they will be well-rounded individuals, and hence worthy employees, effective managers in the classroom and dynamic leaders. Studies on gender dimension to academic performance of students are increasingly featuring across disciplines. Sheard (2009) reported that female students outperform their male counterparts and show more commitment and control over challenges they face during their study. One importance of Sheard's study was that it monitors the students' performance and progress from first year to the final year to track trend. Kirk and Spector (2006) found that GPA, performance in mathematics performance in the statistics course, are all significantly related to success in Basic Algebra

Gender issues in the colleges in colleges of education in Ghana, appeared to be an insignificant variable since less emphasis is placed on it. In collaborative learning environment the participating groups are composed, is one of the most important decisions to be made in a collaborative learning activity (Zurita, 2005).

These compositions produced different learning and social interaction results. Some forms of group learning have become more mainstream than others, and these provided useful direction for the researcher to consider as the researcher weighed the options. The way children learn can affect how well they learn. There are studies which indicate that boys and girls have different styles for learning, and student success can be linked to learning styles (Hein & Budny, 1999).

In collaborative learning, boys' and girls' brains develop differently. While girls develop verbal/linguistic skills early, boys' brains concentrate on spatial and kinesthetic intelligences. Boys needed more movement than girls while they learn which often resulted in discipline difficulties in the classroom (Hall, 2008). Collaborative learning may be described as the mutual commitment of members of a small group to coordinate their efforts in order to solve a problem. Furthermore, in such an environment students can acquire new skills, ideas and knowledge by working together to build solutions to educative problems (Roschelle & Teasley, 1991). Again, in collaborative learning environments, high-ability students prefer collaborative learning in homogeneous ability groups than heterogeneous ability groups. This means that students who are academically more inclined prefer to form a group with those who are as equal or more academically inclined rather than being grouped with a student of lower ability (Shamusudin and Parr, 2006).

It has been shown that male and female students interact with group members differently and that in mixed gender groups males tend to dominate (Guzzetti and Williams, 1996). Therefore, it was proposed that using single gender groups would enable female students to more actively participate. This study explored the effect that arranging collaborative learning groups by gender has on the performance of students

and their level of active Collaborative Learning, Gender and Mathematics Achievement engagement.

Moreover, the researcher wanted to find out at what kind of groupings they would perform better. Recently, it had become increasingly evident that the collaborative learning in the area of Mathematics has become a resource for learning and has gained increasing popularity among education systems, especially in pre-tertiary education in Ghana (Zurita, 2005). Generally, the wide implementation of collaborative learning by Ghana Education Service (GES), The Teacher Education Division(TED) and the National Teaching Council(NTC) in pre-tertiary education had promoted and facilitated increasing innovation in the learning process (MOE,2018). Collaborative learning had become one of the cross-cutting tools in learning process at both the basic and the colleges of education mathematics curriculum in Ghana. Indeed, it forms one of the pillars of the new basic school curriculum approaches to teaching and learning.

Additionally, the benefits gained from using collaborative learning in mathematics learning can be continuously maximized through learning and applying it in effective ways through the use of collaborative environments (Stahl and Steven, 2006). The National Teaching Standards (NTS), the National Teaching Council (NTC), the National Teacher Education Curriculum Framework (NTECF) all focus on collaborative learning from Basic 1 to the Colleges of Education levels in Ghana (MOE, 2018). Collaborative learning had become one of the cross-cutting tools in learning process at both the basic and the colleges of education mathematics curriculum in Ghana. Indeed, it forms one of the pillars of the new basic school curriculum approaches to teaching and learning. Additionally, the benefits gained from using collaborative learning in mathematics learning can be continuously

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The National Teaching Standards (NTS), the National Teaching Council (NTC), the National Teacher Education Curriculum Framework (NTECF) all focus on collaborative learning from Basic 1 to the Colleges of Education levels in Ghana (Newman, 2013). The matter of collaborative environments had been brought to public attention but its implementation leaves less to be desired in Ghana since the traditional method had taken the centre stage of the mathematics classroom. At the same time, education processes and pedagogical concepts must take their rightful place in the mathematics revolution. Furthermore, priority in terms of designing and setting up sustainable strategies and long-term plans for the advancement of society and the education system must be considered as well in the mathematics classroom**.** The new Bachelor of Education curriculum framework among others sought to develop students critical thinking skills, problem solving skills, innovative skills, inclusiveness, Information, Communication and Technology skills and computational and literacy skills through collaborative learning (NTS 1a, 1b, 2c). In fact, the main **4Rs** of the new Basic School curriculum are **R**eading, W**r**iting, A**r**ithmetic and Lite**r**acy.

These pillars largely depend on collaborative learning among pre-tertiary schools in Ghana, where the knowledge and educational level depended on the students' early educational experiences. That means the students who had enriching early educational experiences would be more likely to stay in education and then successfully transfer to the labour market.

In addition, collaborative learning environment is an educational approach that allows students to access learning as soon as possible because, students learn better when they learn with peers or friends. Over the years the colleges of education in Ghana had undergone various transformation in infrastructure, programme and capacity building of both tutors and pre-service teachers. But much had not been seen in area of collaboration where pre-service teachers have the opportunity to collaborate with peers to find solutions to problem solving.

Again, as the only teacher institution responsible to train over 23,000 professional teachers to feed the basic levels of education in Ghana annually, it worth saying that the standard had all over the years been teacher-centred instead of student centred (MoE, 2018). This had been as a result of little effort or no effort put in place for pre-service teachers to collaborate their learning processes. In collaborative learning, students are supposed to research on their own, share what is sought and discussed what had been found with their peers in small groups before presenting to the teacher. Students' collaborative learning is not just another environment that takes more time to develop than other classrooms learning styles. It provides a wide variety of ways of acquiring information, opens new choices for learning, and constructs a smart and flexible learning environment. It also gives fresh approaches to education.

Ghana can boast of 46 public Colleges of Education in the country. There are varying programmes for the colleges depending a college. Some specializations are Science, Mathematics, Agricultural Science, Physical Education, Music, Religious and Moral Education, Social Sciences, Technical and Vocational Studies and information, Communication and Technology.

A workshop organized by the affiliate universities in August 2019 in the various centres indicated that tutors teaching year one Algebra had different methodology of presenting their concepts. Furthermore, within colleges and disciplines, the issue was not different since there were no consultations among members in the mathematics departments (Nketia, 2016). As stated by B.F skinner that the child's mind is an empty vessel waiting to be filled by the teacher, now these concepts are still being used in parallel with differences in Algebra teaching and learning.

The level of interaction and the cost and sophistication of communication are different in each of these types of traditional method of teaching. Although, the tutor covers much within the shortest possible time, pre-service teachers do not develop the four domains except cognitively. But the pre-service teacher who is undergoing professional training in Algebra in the college must develop all four domains in the learning process.

The main reason could be that, the student would go out after college to impart what s/he has learnt to the pupils. If the concepts were not well developed, the ripple effects would be disastrous at the basic levels. Because of this, it was also considered a style of flexible learning, where the college students were to be given the opportunity to account for his/her own learning through active participation in the learning process of our education. In this way, collaborative learning could support different learning styles and allow for greater diversification of students and greater access to mathematics education in Ghana. However, the main problem that faces students of Colleges of Education in Ghana through mathematics in general is not dealing competently with the collaboration, instead students prefer rote learning approach since it is deemed the surest way to success rather than relational learning (Chief

Examiner's report, 2014, UCC). To create a convenient and developed environment, many things should be taken into consideration at the Colleges of Education levels such as the learner's desire, willingness, requirements and needs of the learner.

In addition, successful environments should focus on the academic differences between learners so they fit all the different styles of learning (Manochehr, 2006). Colleges of Education in Ghana offer six major programs in the colleges depending on a college. These major combinations of areas are Mathematics and Science/Agriculture/ Physical Education/Technical Skills, Social Studies and Vocational Skills/Arts, Primary Education, Early Childhood, and French Education. Some colleges offer two or three programs depending the interest and resource of the college. There is a seventh class of special programme for persons living with disability. These special Colleges are Wesley College, Presbyterian College and WA NJA.

It is against this background that the new Bachelor of Education Mathematics curriculum places a lot of emphasis on inclusiveness, gender, equity and equality education among all the Colleges of Education in Ghana (MoE, 2018). In this respect, it is worth mentioning that learning via collaboration enables individual learning styles, which may correspond with the needs of students who avoid voicing their opinions and who are reluctant to speak up or discuss topics in front of other people. Therefore, in collaborative learning, they may be more relaxed and willing to participate in the relative anonymity of the peer group work and small groups can coalesce spontaneously around a topic of mutual interest (Warger & Dobbin, 2009).

In contrast to these levels of individualization, there is also a considerable body of research that had argued for collaborative learning as having powerful effects on

student learning, including student characteristics, group composition, and task characteristics, particularly for low-achieving students (Lai, 2011). Thus, it becomes imperative to understand the impact of learning styles on mathematics learning environment to accurately define different types of learners. Collaborative learning shifts from the teacher being a dispenser of knowledge to a facilitator, guide and mentor since the intention is that students search for information which make them become researchers and self-directed learners, as well as taking responsibility of their own learning (Dooly, 2008).

Ideally, collaborative learning improves the cooperative education programs. It is in view of this that the student-teacher is introduced to peer teaching and student in teaching support (STS) program right from year one to final year 4 in the Colleges of Education in Ghana. Also, collaborative learning has many characteristics such as co-operative behaviour, the acquisition of knowledge, delegating decisions, etc. to develop student trust and retention, which add value to both student and classroom (Stahl and Steven, 2006). Hence, the teacher can determine how to introduce collaborative learning and also where to begin. Colleges of Education in Ghana have a significant impact on changing the curriculum related to mathematics learning by applying the use of manipulative activities and resources.

In addition, applying collaborative learning in mathematics education system in Ghana ensures that goals are attained with little time and effort. Collaborative learning also offers the means to support several forms of tutor-tutor, student-tutor and student-student interactions that permit tutors and students to relate through mathematical means of communication, thereby supporting the social construction of

knowledge (Hassan & Fong, 2012). Therefore, integrating collaborative learning into mathematics education is considered to be a vital approach to learning for students.

In order to teach more effectively on mathematics, the researcher required to find more about collaborative learning and how to deal with the sorts of learning. On the other hand, with collaborative learning, interaction between the students becomes more effective and

it is clear that the interaction and the level of activities are higher in group and team work seem weak in the lecture method classroom, whereas in the collaborative learning environment they are obviously better (Oakley, Felder, Brent and Elhajj, 2004). On the other hand, collaborative learning environment might provide some students with openness and sharing of ideas. Thus, students have an additional role in keeping a learning environment free from defects and under control. Privacy matters for students in the learning environments are more significant in the collaborative learning environments. There is flexibility for students in the collaborative environment and more resilience in dealing with their needs. This might include access to sources, as well as saving time, which allows them to expand their perceptions and prospects. These issues have a greater impact in many psychological and social aspects. In the case of collaborative classroom, the degree of motivation is high for several reasons. Collaborative learning has as its main feature a structure that allows for student talk. Students in the mathematics classrooms are supposed to talk with each other and it is in this talking that much of the learning occurs (Golub, 1988).

In collaborative learning classroom, the facilitator gives the students something to do, not something to learn; and the doing is of such a nature as to demand thinking;

learning naturally results. Collaborative learning produces intellectual synergy of many minds coming to bear on a problem, and the social stimulation of mutual engagement in a common endeavour. Therefore, the current study aimed at examining the positive effects of collaborative learning on the Colleges of Education students in Ghana with regards to their gender groupings and their mathematics achievements. Concerning gender, contribution of gender in collaborative learning outcome is reflected by the contribution of both males and females to the group work, thereby making the discussion more collaborative than in comparison to individual learning. Students' gender brings yet another interesting dimension to this analysis and provides vital information about the ways students engage, collaborate and learn along different gender lines.

The study carried out in (Zeid and El-Bahey, 2011), indicates that females tend to focus more on social oriented activities, while males clearly focus more on task-oriented activities. Moreover, female students learning together in the mathematics-rich environment seem to participate more actively and persistently regardless of the nature of the task (Goldstein and Puntambekar, 2004).

Collaborative learning is a learning process that brings together a collection of individuals both males and females in groups to learn and share information together within the same classroom environment. In Ghana, certain cultures and religion do not allow males and females to sit together. Again, girls cannot speak when engaged with boys. Other beliefs forbid the female to become a leader in a group where there are male students. These beliefs oppose to individuals learning on their own without any specific interaction or activity with anyone (Powell and Kalina, 2009).

Collaborative learning is designed to integrate different genders to function as one, for formal education purpose. In Collaborative learning, there is group creation, group sharing and forums. In order to enhance effective discussion, collaborative learning is made very flexible to pave the way for open discussion. Students are provided with already familiar content, thereby reducing cognitive load and enabling more focus to be placed on collaborative learning.

The aim of Collaborative learning is to stimulate the collaborative learning process and enable instructors to facilitate collaborative assignments more easily. The whole interaction provides data enabling a dynamic analysis of contributions, usage and participation as well as to allow for more advanced future functions such as knowledge elicitation. Collaborative learning can be used by teachers to monitor the contributions of male and female students' mathematics progress in the colleges of education in Ghana. It is against this background that this study had become imperative to the researcher to investigate on the effect of collaborative learning on gender of Colleges of Education students' mathematics achievements in Ghana.

### 1.2 Problem Statement

The study investigated the effect of collaborative learning and mathematics achievement on gender at the colleges of education students in the selected colleges in Ashanti and Brong Ahafo regions in Ghana. This became necessary to find out college students CL style in terms of their gender groupings with respect to their mathematics achievements. The National Teaching Curriculum Framework (Ntecf) 1b which according to Transforming Teacher Education and Learning (T-TEL) report had not been effectively used in the mathematics classrooms in Ghana. The Government of Ghana according to the report was addressing poor learning outcomes

and recognized that teaching is both a barrier and a solution to progress. Getting well-educated, motivated teachers into Ghana's schools is critical to improving the learning outcomes and the country's growth and development. The new Bachelor in Education (B.Ed) curriculum aims to improve the learning experience of pre-service teachers who are ready to teach, inspire and educate Ghana's young people so they can lead the country's progress and prosperity (T-TEL, 2016). This gap manifested in the maiden T-TEL meetings with colleges of education tutors at Sunyani in 2019. In the report, most tutors were of the view that there were more to be achieved in terms of content in the classroom hence, the option for the lecture method. Furthermore, it has also vindicated the status of the National Teaching Council in its gate-keeping role to ensure that teachers met the standard of the profession. It therefore behooves the various stakeholder unions to wholeheartedly support the NTC in its quest to ensure the best for the teaching profession. One of the most serious problems with basic teacher training is the quality of instruction. (T-TEL, 2016). This problem was manifested in the maiden T-TEL meetings with colleges of education tutors at Sunyani in 2019. In the report, most tutors were of the view that there were more to be achieved in terms of content in the classroom hence, the option for the lecture method. Furthermore, it has also vindicated the status of the National Teaching Council in its gate-keeping role to ensure that teachers met the standard of the profession. To maintain Ghana’s forward momentum, the Ministry of Education is looking to develop students with skills in critical analysis and critical thinking. The current education system according to the report is more focused on teaching children to pass examinations rather than solving problems or working in groups.

It therefore behooves the various stakeholder unions to wholeheartedly support the NTC in its quest to ensure the best for the teaching profession. One of the most serious problems with basic teacher training is the quality of instruction. A study by (ODA/GES, 1993:1) indicated that in the Colleges of Education, "approaches to teaching and learning have been largely teacher-centred, emphasizing lectures, dictation and recall of notes". This method of teaching had become an entrenched culture and change-resistant because new approaches are perceived as more time-consuming. Moreover, it favours the examination culture that requires regurgitation of textbook knowledge without sufficient demand on thinking and application skills. Learning in Colleges of Education was heavily examination-oriented. Students were largely the passive recipient of 'content' and 'theory' while methodology and practical teaching strategies were largely ignored. (ODA/GES, 1993:1) The central question for this paper is: Is collaborative learning effective in classrooms, specifically mathematics classrooms with regards to gender groupings?

The use of collaborative learning approach in the teaching and learning of mathematics in Colleges of Education has the potential of enhancing students' achievement. One of the effects of collaborative learning on gender is that both male and female groups with larger sizes, have more knowledge and resources and creative diversity at their disposal which makes them more likely to achieve better performance (Achuonye, 2010). The study concluded that groups with only 1 male student achieved lowest grades, but both male and female groups with larger sizes, have more knowledge and resources and creative diversity at their disposal which make them more likely to achieve better performance. Another effect of collaborative learning on gender groups is the change of performance. A study had

evident that performance drops in groups changed from multi- to single-member (Culbertson and Edgar, 2010).

There are balanced contributions within groups that are only males and there are imbalanced contributions within mixed-gender groups. Another common effect found in the learning patterns of both male and female groups is that even distribution of workload and balanced contribution could improve the learning outcome for both genders. In a study conducted by Dymitr, 2 female students, named as ME and SA, migrated from a mixed group to uniform groups in different course works. Their migration from the mixed group slowed down the contribution in the group. Collaborative learning has been considered as an effective way to improve the learning outcomes of students in contrast to individual learning. However, assigning a group work task to a team of students does not guarantee a successful performance, and in fact could hinder the benefits of group learning if the members do not interact as expected. Indeed, group learning performance is largely (Dymitr, 2014).

The use of CL is one of the most promising learner-centered approaches for students to learn as a group via interaction by using face to face, computers or through Internet (Stahl, and Steve, 2006). The major effect of using CL on gender is that it enables students to share and co-create knowledge through a series of collaborative activities, which helps to improve their problem-solving, decision-making and collaboration skills. In recent years CL affect students' communication skills and share resources more efficiently and effectively (Zhan, Mei and Patrick, 2013).

In turn research outcomes reported (Chunnabathni, and Raskind, 1998), claim that high school girls performed better in single gender groups when learning unfamiliar tasks but excelled more in mixed gender groups when learning familiar tasks. The authors also

suggest that such strategy can improve the development of personal authority and self-confidence among girls in science and math. Despite all these valuable findings and constructive discussions on the role of genders in education reported in the literature, there is still a lack of clarity on the role that gender plays in education particularly in the collaborative learning context. Part of the reason could be that in various investigations the analysis of the role of gender in education is intertwined with 2014 International Conference of Teaching, Assessment and Learning, the students' attitude towards learning and the motivation to accomplish the tasks both of which have been identified as the measures of gender gap (Zeid & El-Bahey, 2011).

The slight gap between the effects of collaborative learning on gender groupings and mathematics achievements of same students which was reported in the Policy Brief document by (Ridge, 2009), posed another challenge. To address the gap a study was conducted in the context of collaborative learning in the Colleges of Education in Ghana in Algebra by the researcher. In summary, the gap identified was on perennial poor performance of colleges of education students in mathematics achievement as a result of frequent use of teacher- centred method of teaching Algebra.

### 1.3 Purpose of the Study

The purpose of the study was to investigate the effects of collaborative learning and mathematics achievement on gender groupings of Bachelor of Education (B. ED) students at the Colleges of Education in Ashanti and Brong Ahafo regions in Ghana.

### 1.4 Objectives of the Study

The study dealt with the following specific objectives:

1. To examine the achievements of college students in the Collaborative learning activities in the three gender groups.
2. To determine the performance of students in the formative test, collaborative learning activity and achievement test in the three gender groups.
3. To investigate whether gender grouping affect students' mathematics achievement in Ashanti and Brong Ahafo regions in Ghana?

### 1.5 The Research Questions

The study was guided by the following research questions:

1. What is the performance of students in employing collaborative learning activities?
2. What is the performance of students in the same and mixed gender grouping using collaborative learning activities?
3. How will gender grouping affect students' mathematics achievement at the College of Education in Ashanti and Brong Ahafo regions in Ghana?

### 1.6 Hypothesis

Research question 2 is formulated in hypothesis form.

*Ho*: There is no significant difference in college students, formative test, collaborative activity and achievement test in the three gender groups at $\alpha = 0.05$ level of significance.

*Ha*: There is significant difference in college students, formative test, collaborative activity and mathematics achievement test in the three gender groups performance at

$\alpha = 0.05$ level of significance.

### 1.7 Significance of Study

The study will provide information regarding which pedagogy is effective to teach college of education students Algebra course. This study will also evaluate the academic performance with which gender group will perform better during collaborative leaning activities in the Algebra class. Data gathered will also help the students improve both academic and group performance at the college of education setting in Ghana and globally.

### 1.8 Delimitation

The study was conducted in Colleges of Education in Ghana during the first semester of 2018 - 2019 academic year. The participants of the study were first year Bachelor of Education (B. ED) students who were enrolled in year one Basic Algebra Course from Ashanti and Brong Ahafo regions.

### 1.9 Limitation of the Study

In interpreting the results of this study, there were several limitations that were considered. These limitations were related to the participants, the length of the study, and the materials used in the course. Another limitation of the study was the length of the experiment.

### 1.10 Organization of the Study

Chapter 1 presents the purpose, importance of the research questions of the study. It will focus on describing the Ghana context, the education system and the need to explore collaborative learning (CL) within this context. Chapter 2 reviews relevant literature that gives a background on the study variables plus education in Ghana, Colleges of Education in Ghana, and then a review of related literature on collaborative learning. Chapter 3 offers a detailed description of the methodology,

materials, and procedures used for collecting the data in this study. It includes information about the colleges, participants, and the research instruments employed for data collection. Chapter 4 looks at the analysis and discussion of the study results and the major findings of these results. Chapter 5 gives a summary of the study results and provides conclusions based on these results, as well as recommendations and suggestions for further research based on the obtained findings.

# CHAPTER TWO

# LITERATURE REVIEW

## 2.0 Overview

The chapter presents a study of the related literature on the concepts of collaborative learning and mathematics achievements on gender in the mathematics classroom at the Colleges of Education in Ashanti and Brong Ahafo regions of Ghana. It also discusses other studies which highlight the collaborative learning, Elements in collaborative learning, role of gender in collaborative learning, theoretical framework, Algebra course design, definition of objectives, role of college tutor, role of student-teacher, design of collaborative learning, new colleges of education in Ghana, main problems and summary of the chapter with reference to collaborative learning on gender groupings and a summary of the chapter.

## 2.1 Collaborative Learning

The idea of collaborative learning as a teaching methodology can be traced back to ancient civilizations between 1950 and 1960. The idea of collaborative learning was first used by doctors to deal and communicate with medical students, where it was noted that the students who were working in groups had medical assessment and results better than those who were working alone. This reflected the great success of this idea. The best way to understand the method of collaborative learning is with the definition of these concepts (Swan, Garrison, and Richardson, 2006, p. 46). There are several advantages of collaborative learning. For example, collaborative learning allows the fostering of a spirit of cooperation among the student-teachers, enhances the potential of the student-teachers, and increases their ability to debate. In addition, the mission of the collaborative learning design is to provide opportunities for

students to communicate effectively to encourage mutual support in order to master the purpose of the lesson. In collaborative learning, there were some skills benefits, which have had a large impact on collaborative learning pressure, like the evolution of overall connection influences, sympathy, and cooperation. This pressure depends on the teacher not as the major supplier of information or control, but as a facilitator (Bower and Richards, 2006).

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**2.2 Some Definitions of Collaborative Learning**

Collaborative learning is a teaching strategy that includes a small group of learners working together in order to develop the educational experience to the maximum extent possible (Jane and Christine, 2009). Collaborative learning may be defined as the work of individuals as members of groups, and each student of the group is linked to mental, emotional, and behavioral functions to achieve the objectives of the

community and systems whose clear objectives help learners in the decision-making process and increase the sense of community. Collaborative learning is an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together. Usually, students are working in groups of two or more, mutually searching for understanding, solutions, or meanings, or creating a product. Collaborative learning activities vary widely, but most center on students' exploration or application of the course material, not simply the teacher's presentation or explication of it (Barbara, Dario and Daley, 2017).

Arguably collaborative learning aims to support the most effective teaching possible for the greatest number of students. "Collaborative learning" is an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together. Usually, students are working in groups of two or more, mutually searching for understanding, solutions, or meanings, or creating a product (Barbara, Dario and Daley, 2017). Collaborative learning activities vary widely, but most center on students' exploration or application of the course material, not simply the teacher's presentation or explication of it. Collaborative learning represents a significant shift away from the typical teacher-centered or lecture-centered milieu in college classrooms. In collaborative classrooms, the lecturing/ listening/note-taking process may not disappear entirely, but it lives alongside other processes that are based in students' discussion and active work with the course material. Teachers who use collaborative learning approaches tend to think of themselves less as expert transmitters of knowledge to students, and more as expert designers of intellectual experiences for students-as coaches or mid-wives of a more emergent learning process (McGregor and Murnane, 1992).

### 2.3 Collaborative Learning Strategy

In a study of students with strong preferences to learning alone or learning in groups, found that those preferring to learn alone "evidenced statistically higher mean lesson-test scores than those who were identified as preferring to learn with peers" (Wallace, 1993). Wallace suggested the possibility that this result is due to a traditional structure in the classroom, and that the organizational pattern in the classroom had not matched a preference to working with peers.

On the other hand, memory research indicates that children remember best by discussing what they have learned in groups, practicing and using what they have learned, and by teaching others (Madrazo & Motz, 2005). In the collaborative learning classroom, females contribute to small mixed gender groups just as they would within the larger mixed gender classroom and that there is a notable difference in the approach each gender takes to learning physics and interacting with others. Male students are more likely to make predictions quickly, avoid questions to which they do not know the answer, provide answers and look for concrete solutions (Culbertson, 2010). Female students, on the other hand, tend to raise questions about the content, do not present solutions right away, invite other members of the group to participate, and look to build consensus. It has also been shown that male and female students present their objections to a learning group in very different manners. Males tend to disagree more than females in a learning group (Culbertson, 2010). Males require the group members to give evidence to any statement that is made that contradicts their reasoning for a particular phenomenon, whereas female students tend to use an indirect approach by raising questions and stating possibilities to raise their objections (Guzzetti and Williams, 1996).

Furthermore, it has been shown that male students tend to ignore the female students' ideas and interrupt females as they try to explain their ideas. Collaborative Learning, Gender Groupings and Mathematics Performance as mentioned by Guzzetti, that there are also studies that show that this method is nonconductive to learning. There is a conclusion that students who receive help from their peers may or may not improve their performance (Peterson, Janicki, and Swing, 1981). In collaborative learning, low achieving students are hindered by the fact that they may be holding their group back in a task (Covington, 2016). When comparing homogeneous male and homogeneous female pairs in collaborative tasks, researchers have come to many different conclusions. Some research has found that male pairs are more effective than female pairs in collaborative learning tasks. Male pairs accomplish tasks in the shortest amount of time possible and are very competitive in their tasks (Webb, 1991).

Again, in collaborative learning, female pairs are more efficient in collaborative learning. In this learning environment, the females' work is more deliberate and consistent to make sure that the task is completed and that the fewest number of mistakes are made (Cohen 1994). The conclusion of researchers such as Webb is that homogeneous pairs outperform heterogeneous pairs. Although boys competed and girls cooperated, both types of pairs still achieved their goal of getting the computer task done effectively. This was not the case with heterogeneous pairs because the male trait of competition and female trait of cooperation kept both children from working together. In the study of "The Effects of Gender Grouping and Learning Style on Student Curiosity in Modular Technology Education Laboratories", the overall scores for girl/girl groupings were higher than girl/boy and boy/boy groupings, and scores for girl/boy groupings were higher than boy/boy groupings. A one-way analysis of variance was conducted to evaluate whether the gender grouping means

differed significantly from each other (Draper, 2004). According to the analyses, the F-tests revealed no significant differences in gender groupings. (Kowaliw, 2017) in his study, "Homogeneous and Heterogeneous Gender Pairs, Controlling Behavior, And Achievement on a Cooperative Learning Task", found his hypothesis that homogeneous male and female pairs would complete the task before heterogeneous pairs was incorrect; males took the longest to complete the task. Researchers also disagree as to which type of gender pair works most productively. In "The Effect of Single Gender Cooperative Learning Groups in High School Physics Classes", there was indication that the gender gap is reduced when single gender groups are used, without detriment to male students, and those students, on average, prefer single gender cooperative groups (Culbertson, 2010). Gender bias is about much more than measured pay gaps. In fact, measured pay gaps are very bad at identifying women who feel that they have experienced discrimination (Cohen, 1994).

In the mathematics classroom in Ghanaian colleges, the facilitator of mathematics must bring all students together in the learning environment. No student should be left behind in order to achieve complete results. Most students sometimes feel discriminated by their own peers when it comes to group work. This could be as a results of a particular gender grouping one finds him/herself. This is why this study had become imperative to investigate college students in Ghana mathematics achievements against the collaborative learning activities in the classroom. This study sought to bridge this gap by putting all categories of persons from different gender, same gender and students from diverse political ideologies and beliefs into small groups where they could work together irrespective of one's preference.

## 2.4 Elements of Collaborative Learning Environment

The following are some of the collaborative learning environments in the mathematics classroom:

1. Collaborative learning obviously perceives positive correlation; members in the work group are committed to depend on one another to achieve the set goal. And if any member fails to perform his/her task or responsibility, all members in the group suffers the consequences. This means the teacher must plant in the hearts of the learners the importance of collaborative teaching to build a collaborative learning environment.
2. Great communication and interaction: Developing effective communication skills to interact with others contributes to an exchange of information and ideas through various channels to achieve the goals. Furthermore, successful communication depends on several factors such as the interaction between the teacher and the learner and between the learners themselves and the means of delivery in addition to the effects of the surrounding environment.
3. Individual accountability and personal responsibility: Each student in the team is responsible for performing their task and reaching a high level of mastery.
4. Social skills: Understanding behaviour of each student is imperative to succeed. There are a set of social skills learners should have such as confidence, calm, decision making, empathy, smiles, and communication.
5. Group self-evaluating: In order to improve the teaching and learning process and development, this should focus on the importance of a teacher competency standard in educational process and student assessment such as philosophy of education goals, defining curriculum content and textbooks

under consideration, identifying objectives **and analyzing their content, acknowledge of** them learning styles.

On the other hand, many previous studies and literature confirms the significance of effective participation and collaboration by students in supporting the effectiveness of the learning process. The evaluation of collaboration needs a radical rethinking of approaches and methodologies. In this context, three main issues are involved in the assessment process:

1. The variety and kinds of goals for collaborative learning: These include distinguishing between the teacher who built the learning goals for his students on a collaborative basis, and between the teacher who built it on a competitive basis, or individually.
2. In addition, collaborative learning should distinguish between students who work in the form of learning groups, or conventionally, and among the students who work in the form of cooperative learning groups.
3. Furthermore, collaborative learning should distinguish between each element of the basic elements of cooperative learning that have been implemented in the successful image (Swan, Garrison and Robertson, 2006).

Arguably, even with these different groups, the same kind of evaluation will not be suitable, because learning goals differ from implementation to implementation, for instance, distinguishing between structured and emergent collaboration schemes from one university of affiliation to another are all factors to consider in the mathematics classroom.

It sometimes also depends on the beliefs of the course coordinators of the various affiliate universities to these colleges in Ghana. In the latter sorts of collaboration activities, assessment must also emerge. What is consistent across the varieties of

classroom collaboration is that collaborative learning will be more successful when it is valued, and that any such assessment should begin with a very specific understanding of desired learning. And in some collaborative activities, learning to collaborate is seen as an important part of what is to be learned (Swan, Garrison and Robertson, 2006). In others, it is merely a means to an end. In some collaborative activities, collaboration is focused on producing a group project, in others it is designed to improve the quality of individual work. In conclusion, particular requirements for collaboration, containing detailed evaluation concentrated on crucial collaborative processes, will assist students achieve the desired aims.

Other issues refer to the complication of evaluating individual and group behaviours, where collaborative learning represents a complicated activity and to support collaboration, individual and group aspects must be evaluated. This means the main building block of successful collaborative learning is integrated between the objectives of collaborative learning on the one hand and the goals of the learners on the other hand. However, to ensure the continued success of a collaborative learning strategy, it should succeed on an individual level. An example of this type of evaluation is using summative testing is to give each student a grade based on some combination of their test score and the average score for their group (Swan, Garrison and Robertson, 2006). Another frequently used scheme is to give a common assessment for a group project and have group members rate their peers' contributions which are then averaged for individual grades. Unfortunately, these kinds of grading protocols are not often seen in the Algebra courses at the college level where the common approach is to assess either individual effort e.g., (discussion participation) or group products (collaborative projects).

Collaboration on assessment itself becomes effective when objective for learning had been achieved and its effect becomes necessary when the practice is rooted in spirit and the heart of the teaching and learning process. Thus, the teacher uses a package of tools aimed at providing assistance through the presentation of aspects and activities of the collaborative learning plans to find the desired interest such as rebound, questions design and comment trapped correction. Actually, collaborative learning can be a defined teaching technique, which is invested in the learning process, and can enable more than one leaner (a group of three to five people, a class of twenty to thirty students, a community of hundreds or thousands of people, or even millions of people) to learn something related to studying course material, following a course, problem solving (or other learning activities) or even learning from lifetime work practice together (including several classes of communication, synchronous or non-synchronous, traditional (lecture method), common in time or not, computer mediated, common effort or separately (Dillenbourg, 1999).

**2.5 The Role of Gender in Collaborative Learning**

Studies have compared individuals in group with individuals working alone and found that those who collaborated with others performed better in their individual learning post-tests than their counterparts who worked alone. This result may reflect that cognitive capability is only a partial answer to the understanding of learning process, while other factors such as social collaboration should also be taken into account. Vygotsky and Piaget are two influential developmental psychologists that support this idea cited by (Rogooff and Tudge, 1999) in "Peer influences on cognitive development: Piagetian and Vygotskian perspectives" (Vygosky, 1999). They both deemed that peer collaboration is likely to improve individuals' cognitive capability and thereby advance their learning outcome.

In collaborative learning, there are two very different approaches in order to achieve a result. That is, that language is a cultural and psychological tool allows people to establish, share meanings and structure the content of individual thoughts through the use of dialogues like discussion (John-Steiner, Weber and Minnis, 1996). Then the construction of mutually satisfying meanings by coordination and the integration of two or more peoples' differing perspectives are likely to lead to cognitive improvement and acquisition of the share meaning. On the other hand, Piaget highlighted that learning is the outcome of equilibration. This is a process that involves the reconciliation by individuals of conflicts between prior and newly experienced beliefs. This process is likely to result in cognitive change and learning of the reconciled knowledge (Doise and Mugny, 1984).

Overall, whatever approaches, they both consistently suggest the effectiveness of collaborative learning. Nevertheless, a number of studies have criticized that not all individual can benefit equally from it (Ding, Bosker and Harskemp, 2008). How much each individual can benefit from collaborative learning varies based on multiple factors such as gender differences. Hence, this essay will discuss how gender moderates the effect of collaboration on learning by evaluating the influence of individual gender effects, gender composition and the ratio of the group.

Firstly, Ding et al found that females did not benefit as much as males from collaborative learning. In this experiment, they investigated their problem-solving process on Newtonian mechanics. Participants were asked to solve three new and moderately structured problems with their partners. The result suggested that, after discussion, males and females improved 22% and 10% respectively when comparing their individual pre-and post-tests. Accordingly, this documented that boys tend to

benefit more from collaborative learning compared to girls. In collaborative learning, boys and girls have different communication styles and therefore this may result in benefit to boys more than that to girls (Bearison and Filardo, 1996). Girls in collaborative learning environment are prone to disagree with no further justification, whereas boys tend to disagree with concrete evidences and explanations. Some research tried to tie this distinction with the self-explanation effect (Bassok, Chi, Lewis, Reimann and Glaser, 1989).

That is, when boys explain their arguments to their group mates, they are at the same time self-assessing their understanding of the argument in mind. Thus, this internal process is likely to improve boys' understanding of the issue and improve their learning outcome of it. By contrast, whilst girls provide vague disagreement, this processing is less likely to be triggered in girls. This provides a cognitive explanation of why boys may benefit more from collaborative learning than girls. Nevertheless, empirical research on the association of verbal disagreement with explanation and cognitive processing is limited. Further research in this field is recommended.

On the other hand, contrary research was found in a real classroom experiment with high ecological validity. Participants were students enrolled in a digital design class and each of them were grouped with three other participants. They were required to complete multiple choices as pre-test in their first class. During the semester, participants were required to post their thoughts and questions to the online discussion board in group. Moreover, after each class, participants reflected about the content learned in the class and discuss assignments with their group mates. The result demonstrated that girls improved 10% more than boys in their individual post-tests at the end of the semester (Zhan and Mei, 2012).

Although this experiment is criticized that it could not control interaction outside the classroom and this might affect the result, it is still strongly believed that it provided empirical evidence to imply that girls may benefit more than boys from collaborative learning. It is observed that girls are more likely to work toward a consensus and therefore they may benefit more than boys from Zhan and Mei. This suggestion is in line with Vygotsky's idea which highlights that an effective collaboration depends upon the establishment of share meaning, so girls in this way may improve more. To evaluate the two contradictory findings, perhaps, a child's learning effectiveness cannot simply be interpreted by his or her gender. Rather, it depends on the context of participation. Boys who improved more from collaborative learning, required interaction with opposite-gender participants, whereas Zhan and Mei (2012), investigated same-gender collaboration and stated that girls benefit more in collaborative work.

Based on these differences, it is argued that group composition with respect to gender seems more likely to be a greater moderator on the effects of collaborative learning than individual gender differences. In order to examine the effectiveness of gender composition on collaborative learning. Ding, Bosker, Harskamp (2011) randomly paired participants with a same-gender or an opposite- gender partner to overcome a number of structured problems related to Newtonian mechanics across two weeks. The comparison of the pretest and posttests demonstrated that all participants who collaborated with others improved in their individual post-tests while participants who worked alone had no improvement, despite this improvement was criticized that this might be due to more practice sessions offered for collaborative participants than alone participants during the two weeks. Most importantly, the result further found

that male participants performed identically well in both same-gender and opposite-gender groups.

Bosker and his colleagues observed that boys reacted equally active no matter what gender they were paired with and, perhaps, this consistency of communication style leads them benefit from collaboration regardless of gender composition. Boys were assigned to work with either more-able males or more- able females so as to solve a task of conservation of liquid. Learning improvement was assessed by their pre-and post-test differences. As a result, boys who interacted with girls improved the most compared to those grouped with boys and those working independently. This result is against (Ding, Bosker, Harskamp, 2011).

Additionally, unlike Bosker and his colleagues' observation, gender composition is likely to influenced the type of conversation that boys used in their discussion. Boys were more likely to disagree with their female partners than their male peers. This is in line with Piaget's idea that boys with female partners are thus likely to re-examine their initial knowledge cognitively and need to recognize a higher order solution to the problem which resolve the apparent conflict (Duveen and Charis, 2006). Hence, they may understand more and improve more eventually from collaboration.

By contrast, as there was less disagreement, this socio-cognitive process is less likely to be generated in boys who interacted with other boys and hence they may improve less. Nonetheless, rather than seeing the two studies as contradictory, this is better to perceive the current research as an extension of Bosker and his colleagues' study. That is, other individual differences, such as ability, may interact with gender composition in influencing the effectiveness of collaborative learning in the mathematics classroom. Moreover, a number of studies have shown that distinct

gender composition may impact learning effectiveness in girls (Ding, Bosker, Harskamp, 2011).

Secondary school girls were grouped with males or females to overcome moderate physics problems in a two-week experiment. By comparing their individual per-and post-tests, girls with other females outperformed their counterparts who worked with males. Similar result was documented by (Ding and Haskamp, 2006) who recruited Chinese students in Shanghai. These findings are thus culturally valid for demonstrating that, unlike boys, gender composition matters to girls and single-gender is superior to mixed-gender for girls. In collaborative environment, girls who interacted with same-gender group mates were more likely to joke and laugh with each other, therefore they were less stressful in the conversation compared to those in mixed-gender composition (Underwood and Underwood, 1996). This observation is further elaborated through the idea of spring. While same-sex girls feel less pressure, they were more likely to build trust with and support each other compared with mixed-gender group. This positive interpersonal relationship therefore leads these girls to respect each other's opinions more and facilitates the establishment of common consensus emphasized by Vygotsky (Berdondini, Kutnick and Ota, 2008). Thus, this superior peer collaboration is likely to lead to a more outstanding learning outcome in girls interacting with same-sex peers than interacting with mixed-sex group mates. Nevertheless, the conclusion of girls being unlikely to benefit from mixed-gender composition is criticized by (Webb,1991).

His main argument was that mixed group can be categorized into balance and imbalance mixed gender composition and whether a girl or a boy can benefit from mixed-gender group mates depend on the gender ratio of the group. It is because

males and females are likely to interact differently in different gender ratio and this may result in uneven benefit to the girls and boys from the group. It was found that girls were unlikely to benefit from collaborative learning in imbalanced mixed-gender groups, whereas opposite phenomenon was found in boys.

Boys and girls were randomly assigned to groups of three females and one male or groups of one female and three males to learn mathematics (Webb, 1991). The result suggested that no significant improvement was found in girls in their individual measurements regardless of gender ratio, however boys improved identically well in both majority male and majority female compositions. Webb observed that boys were more likely than girls to give and receive elaborated explanations and they were more likely to be requested for help from their group mates. This may trigger the self-explanation effect as discussed and therefore lead boys' benefit from collaboration. However, on the other hand, girls' responses were often ignored by their male peers and boys usually dominated the conversation in both majority male and majority female groups, leading girls fail to achieve the dyadic interaction highlighted by Vygotsky's and Piaget's ideas of a successful collaborative learning.

Therefore, this gives an explanation of why girls may not benefit from imbalance gender ratio. Boys' dominance significantly reduced when they participate in a language task compared to a computer-based task. This may imply that boys have greater dominance in areas that they are more interested in or talented at (Barnes, 2000). This again suggests that other elements, such as task nature in this case, may interact with gender composition in influencing the effect of peer collaboration on learning. Despite, imbalanced mixed group seems only benefit boys instead of girls, balanced ratio benefit both consistently as suggested by Webb.

Secondary school students collaborated with two males and two females for two weeks to learn exponents and scientific notation. Two weeks later, both males and females achieved significantly well in their individual post-tests. It was noticed that males' dominance had shown improved and more even contribution to group work between genders was found in balanced mixed composition (Webb,1991). This means that, unlike imbalanced gender group, there is a two-way discussion in equal ratio. This therefore allows individuals to express their perspectives and to generalize different perspectives into one share meaning and then to reconcile individual conflict in mind. This cognitive improvement is likely to advance boys' and girls' interpretation of the discussed issues and hence they may learn the issues better than before. Accordingly, both boys and girls are able to benefit from collaborative learning when it is an even gender composition (Webb, 1991). The result that females tend to benefit from same-gender and balanced ratio groups while males' benefit from all sorts of gender ratio compositions has vital implications for schooling and accordingly maximizing students' learning capacities. Teachers in co-educational schools are recommended to assign children to same gender or balanced mixed groups for group activities as these two types of composition are going to benefit all students and guarantee consistent cognitive improvements on both genders.

Teachers at the colleges of education mathematics classrooms in Ghana are, at the same time, suggested to pay attention to a number of factors, including the nature of the task and the ability difference among peers that may have influence on the effectiveness of collaborative learning. As discussed, boys interacting with more-able girls outperformed boys cooperating with less-able girls and same-sex peers regardless of their ability (Duveen & Psaltis, 2006). Hence, teachers are proposed to

encourage interaction between less-able boys and more-able girls. Additionally, imbalanced ratio group is relatively discouraged.

However, if the imbalanced mixed group is inevitable, teachers are advised to modulate the task nature in order to improve the asymmetrical gender benefits from collaboration. For example, Barnes, Joiner, Keogh and Littleton (2000) found that girls improved less because boys dominated the interaction in imbalanced gender group, but this dominance abated if the task was not a male-preferred task. Accordingly, teachers are suggested to allocate students to an art task instead of a science assignment, so that both genders may as well be beneficial (Barnes, Joiner, Keogh and Littleton 2000).

To conclude, evidence suggests that collaborative learning does not benefit everyone identically and how much each individual can benefit from it varies according to multiple factors such as gender differences. Nevertheless, contradictory results were found. Some studies demonstrated that boys' learning outcomes improve more than that of girls, whilst other research documented that girls outperform boys. Hence, this means that, perhaps, a child's learning effectiveness cannot simply be interpreted by his or her gender, but rather the context of participation such as gender composition. It is found that boys' benefit from both same-gender and mixed-gender groups while females only benefit from the same-gender group. However, it is criticized that the mixed- gender group can be classified into balanced and imbalanced gender ratio compositions. As a result, females tend to benefit from same-gender and balanced ratio groups while males' benefit from all sorts of gender ratio compositions.

Nonetheless, it needs to be aware that the effect of peer collaborative learning may be impacted by the ability differences between group mates as well as the nature of the task. Lastly, all these findings provide significant implications for schooling in order to improve students' learning. In a study of students with strong preferences to learning alone or learning in groups, it was found that those preferring to learn alone had higher mean lesson-test scores than those who were identified as preferring to learn with peers (Annelies, 2015). There is a possibility that this result is due to a traditional structure in the classroom, and that the organizational pattern in the classroom had not matched a preference to working with peers. On the other hand, memory research indicates that children remember best by discussing what they have learned in groups, practicing and using what they have learned, and by teaching others (Madrazo and Motz, 2005).

Females contribute to small mixed gender groups just as they would within the larger mixed gender classroom and that there is a notable difference in the approach each gender takes to learning physics and interacting with others. Male students are more likely to make predictions quickly, avoid questions to which they do not know the answer, provide answers and look for concrete solutions. Female students, on the other hand, tend to raise questions about the content, do not present solutions right away, invite other members of the group to participate, and look to build consensus (Culbertson, 2010).

It has also been shown that male and female students present their objections to a learning group in very different manners. Males tend to disagree more than females in a learning group. Males require the group members to give evidence to any statement that is made that contradicts their reasoning for a particular phenomenon,

whereas female students tend to use an indirect approach by raising questions and stating possibilities to raise their objections (Guzzetti and Williams, 2008). Furthermore, it has been shown that male students tend to ignore the female students' ideas and interrupt females as they try to explain their ideas. As mentioned by Edgar, that there are also studies that show that this method is nonconductive to learning. There was a conclusion that students who receive help from their peers may or may not improve their performance (Peterson, 2016). Low achieving students are hindered by the fact that they may be holding their group back in a task. When comparing homogeneous male and homogeneous female pairs in cooperative tasks, researchers have come to many different conclusions. Some research has found that male pairs are more effective than female pairs in collaborative learning tasks (Covington, 2016).

In collaborative classroom, male pairs accomplish tasks in the shortest amount of time possible and are very competitive in their tasks. Other research states that female pairs are more efficient in cooperative learning (Webb, 1991). In conclusion, females' work is more deliberate and consistent to make sure that the task is completed and that the fewest number of mistakes are made (Cohen, 1994). The findings further explained that females contribute in group learning than their male counterparts. The series of detailed cross-gender learning engagement and performance comparisons indicate that female groups tend to work simultaneously and achieve better results while male group members engage less and work in sequence. As result female groups benefit in collaborative learning more than the male groups Zeid and El-Bahey, 2011).

What is striking, however, is that what gender in a mixed-gender groups excel the most, with reference to their engagement, focus and the quality of group work as well as same gender groupings. As a student of mathematics and collaborative learner, most of the groups we used to form were based on friendships and course mates. No proper composition was considered in the formation of the study groups.

It is believed that females contribution to mixed group discussions delivers yet another proof of the synergies and efficiencies of interactive learning in a diverse group of students and encourages mixing genders when composing groups for collaborative learning. Significant research has been dedicated to study and compare the effectiveness of single-gender education and co-education with various gender compositions of classrooms (Kim, 2017). The focus of these studies varied from trying to employ gender-specific educational strategies to enhance students' confidence and skills to trying to improve learning outcomes and achieve social mobility (Zeid and El-Bahey, 2011).

**2.6 Theoretical Framework**

Collaborative learning depends on constructivist theory, which posits that knowledge is built and translated through students. The learning process must be realized as something learned through activation of the existing cognitive structures or by building new cognitive structures that adapt to new input. Instead of passively acquiring knowledge, learning takes place between all the students and teachers in the process.

Furthermore, collaborative learning is described from different angles: social presence, motivational forces, cognitive presence and community of inquiry (Lowyck & Pöysä, 2001). Thus, the students at Colleges of Education in Ghana need tools that

will enable them to take charge of the learning process itself rather than following the traditional methods used in schools and Colleges. In addition, the students need projects and workshops that aim to encourage and develop their skills through courses in different fields, which support collaborative learning, (Anderson, 2014). Concept Collaborative learning is a model of teaching where students work together with others in order to reduce the negative outcomes and increase the contentment that comes through the operation at a high level of the group's execution.

Collaborative learning is an effective learning model in higher education. This type of learning provides many advantages for students: for example, collaboratively instructed learners want to demonstrate higher academic accomplishment, improved high-level reasoning and critical thinking skills, and encourage more positive behavior in the direction of topic fields and advanced self-esteem, deeper understanding of learned subjects, additional positive and supportive interactions with colleagues, increased time spent on tasks and reduced problem behaviour in the classroom, improved inherent motivation toward teaching and greater power to consider situations from others' perspectives and reduced levels of anxiety and stress (Felder & Brent, 2007). Collaborative learning is a component of a team of education/learning methods, whereas learners collaborate with each other in order to gain objectives and to address mutual learning objectives.

Collaborative learning is significantly more than placing learners together in sets and hoping for the best. It is an extensive official means of arranging actions in a learning environment that contains particular factors aimed to provide the potential for effective and pure study for the learners. The essential advantage of collaborative learning is its ability to deal with different circumstances in an orderly manner and

that makes it easier for learners to move from one phase to another. In addition, Collaborative Learning models comprise the following basic rules:

1. Designing the group tasks in order to be convenient for group work. Building positive interdependence and cooperation, which are vital for students to succeed. Giving class time and attention to the development of interpersonal/cooperative skills.
2. Encouraging students to learn from each other in small groups (2-5 members).
3. Asking questions individually for learning and participation.
4. Changing the mission of teachers so as to act as an educational facilitator, this provides guidance to students to interact with each other (MacPherson, 2008).

However, effectiveness of peer evaluation can be limited if the learners feel a sense of competition toward one another, as this can adversely affect the reliability of feedback (Tsay and Brady, 2012). Moreover, students may still worry about the way they and their colleagues are ranked. In order to address such concerns, moving learners away from their team once teams' examinations have been completed will probably lead to more reliable reactions. An additional factor that might increase competition and motivation for cooperation is to apply a principle referenced ranking system to assess teamwork instead of rating on a curve. Collaborative learning, an instructional strategy, includes students working together to achieve a mutual target in circumstances, which contains the following factors (Felder & Brent, 2007).

Positive interdependence, as all members of the team are compelled to trust each other in order to accomplish the team's targets. Therefore, if one of them fails to accomplish the assigned work, the others members will suffer the consequences. In collaborative learning, face-to-face promote interaction. Team work as a process to

work collaboratively to promote interaction instead of that achieved separately, but only through team work, by distributing the sub-tasks between team members, supporting each other, getting feedback, motivating, and possibly most significantly, instructing and inspiring one another. Appropriate use of collaborative skills, as learners are urged and assisted to improve and apply decision-making, trust-building, communication, conflict management skills and leadership, Group processing, evaluate the members of a groups regularly in order to determine whether or not each member is working on the group goals, how he/she is working on the overall objectives and how he/she can improve the group's work in future.

### 2.7 Challenges and Opportunities of Collaborative Learning

Creating a collaborative classroom can be a wonderfully rewarding opportunity but it is also full of challenges and dilemmas. Few of us experienced collaborative work in our own undergraduate settings, and much of our graduate school training reinforced the teacher-centered, lecture-driven model of college teaching. For each of us, stepping out of the center and engaging students in group activity is hard work, especially at first.

What is Collaborative Learning? Washington Center for Improving the Quality of Undergraduate Education Designing group work requires a demanding yet important rethinking of our syllabus, in terms of course content and time allocation. If some (or a great deal) of the classroom time is considered an important social space for developing understandings about course material, or if some of the out-of-class time is devoted to study groups or group projects, how should we design the rest of the class time (lectures, assignments, examinations)?

How do we ensure students are learning and mastering key skills and ideas in the course, while at the same time addressing all the material of the course? Teaching in collaborative settings puts front and center the tension between the process of student learning and content coverage. As we become more involved in using collaborative learning, we discover what radical questions it raises.

Collaborative learning goes to the roots of long-held assumptions about teaching and learning. Classroom roles change: both teachers and students take on more complex roles and responsibilities (Finkel and Monk, 1993: MacGregor, 1990). The classroom is no longer solo teacher and individual students. It becomes more an interdependent community with all the joys and tensions and difficulties that attend all communities. This degree of involvement often questions and reshapes assumed power relationships between teachers and students, (and between students and students), a process that at first can be confusing and disorienting (MacGregor, Anne, Mahr, Tinto and Barbara, 1992). The classroom is no longer solo teacher and individual students. It becomes more an interdependent community with all the joys and tensions and difficulties that attend all communities. This degree of involvement often questions and reshapes assumed power relationships between teachers and students, (and between students and students), a process that at first can be confusing and disorienting (Romer and Whipple, 1990). Not only is course content reshaped, so are our definitions of student competence. Because the public nature of group work makes demonstration of student learning so continuous, collaborative learning both complicates and enriches the evaluation process.

Challenges to collaborative learning at the classroom level are compounded by the traditional structures and culture of the academy, which continue to perpetuate the teacher-centered, transmission- of-information model of teaching and learning. The political economy of the academy is set up to front load the curriculum with large lower division classes in rooms immutably arranged for lectures, usually in classes limited to fifty-minute "hours." Student-student interaction; extended, careful examination of ideas; the hearing-out of multiple perspectives; the development of an intellectual community all these are hard to accomplish under these constraints.

The lecture-centered model is reinforced (both subtly and blatantly) by institutional reward systems that favor limited engagement in teaching, and give greater recognition to research. Achievement for teachers and students alike is assumed to be a scarce honor, which one works for alone, in competition with peers. This assumption of scarcity is the platform for norm-referenced grading, or "grading on the curve," a procedure that enforces distance between students and corrodes the trust on which collaborative learning is built. Moreover, our definitions of ourselves as teachers, as keepers and dispensers of disciplinary expertise, are still very much bound up in the lecture podium. For example, a colleague recently told us a poignant story about his dean coming to observe his teaching. The dean looked into the room where students were avidly engaged in small group work. What is Collaborative Learning? Washington Center for Improving the Quality of Undergraduate Education Turning to leave, the dean answered, "Oh, you're doing groups today. I will come back when you're teaching." We have a long way to go. What really has propelled us and our colleagues into collaborative classrooms is the desire to motivate students by getting them more actively engaged. Nonetheless, wanting to be a facilitator of collaborative learning and being good at it are very different things.

As with all kinds of teaching, designing and guiding group work takes time to learn and practice. And for students, learning to learn well in groups doesn't happen overnight. Most teachers start with modest efforts. Many works with colleagues, designing, trying and observing each other's approaches. At their best, collaborative classrooms stimulate both students and teachers. In the most authentic of ways, the collaborative learning process models what it means to question, learn and understand in concert with others. Learning collaboratively demands responsibility, persistence and sensitivity, but the result can be a community of learners in which everyone is welcome to join, participate and grow.

### 2.8 Algebra Course Design

Algebra is a first year first semester course defined as one of the standard academic theoretical courses that are provided to all Colleges of Education students in Ghana. The goals of the course are represented in highlighting a generation of students that have many of the skills, abilities and capabilities. Since the current study revolved around this course it is important to briefly describe this course. The Algebra course, contains units in the following fields: An introduction to the learning, teaching and applying Number and Algebra (traditional and modern concepts); the elements of complex numbers, misconceptions, equations and inequalities, real number system, set and its applications. This is in addition to addressing their portfolio building and Supporting Teaching in Schools (STS) supervisions. The purpose of this course is to guide pre-service teachers to develop their cross-cutting issues and linking the concepts to its applications in this course.

## 2.9 Definition of Objectives

The Algebra Course was approved and provided by the Transforming Teaching, Education & Learning (T-TEL), Ghana National Teaching Council (NTC) and all affiliate universities in Ghana. The objectives of the course include understanding the concepts and components of the mathematics process and clarifying mathematics procedures. It also aims at clarifying everyday problems and their sources, create awareness of different mathematics paradigms and their applications for studying Algebra and Number, develop the ability to suitably select and cite information sources related to different study topics, develop the ability to effectively prepare a portfolio, and finally to understand and demonstrate commitment to mathematics ethics.

## 2.10 The Role of the College Tutor in the Collaborative Classroom

As mentioned above, collaborative learning has a variety of common skills benefits such as sympathy and cooperation. This depends on the teacher not as the major supplier of information or control, but as a facilitator, thus it is important to investigate the teacher's role in educational operation. The college tutor can be male or female regardless of the college. There are several roles for Colleges of Education tutor in general collaborative learning, such as developing student-teachers' confidence as they become used to working together in the mathematics classroom. It also makes available resources that students can access during the collaborative learning, posting explanations to guide student-teachers in more complex tasks.

Again, it seeks to encouraging student-teachers to communicate, employing all the platform tools they have at their disposal to facilitate their work and do their individual assignments. Tracking continuously student improvements and giving a boost when

motivation starts to decrease, checking and marking the assignments, filling in students' progress reports and writing feedback on their operation in their portfolios in school in teaching support, encouraging students to accomplish their collaborative work tasks. This type of learning is usually difficult as the students have different schedules and are not used to working collaboratively to attain learning tasks and are also living separately.

In addition, roles of tutors in collaborative learning are as follow:

1) Content facilitator, who acts like a field professional, translator and leader throughout the ideas of education.
2) Metacognition organizer, who focuses on education actions, results and improvements to learning abilities.
3) Process organizers, who supports students' knowledge strategies and time management.
4) Consultant, who supplies pastoral support and a route to institutional/local support systems.
5) Assessor sometimes called examiner, who provides feedback on task accomplishment, performance and assignment growth.
6) Technology guide, who supports learning with tools and technologies.
7) Resource supplier, who describes and positions, formulates and develops resources in order to offer learning provision in requirement time.
8) Manager and administrator, who support the direction of the course, maintain records and controls enrolment.
9) Designer, who intervenes, assists and plans the course path and the lesson itself educates and completes the tasks.

10) Co-learner, who frequently, function is not as a 'sage on the stage' or even 'guide on the side', but really 'friend to the end' of the course, walking with the student-participants and learning alongside them.

11) Researcher, who is able to reflect on his/her experience, and who works on the basis of this mathematics experience according to (Bjekic, Krneta and Milosevic, 2010).

From the researcher perspective, the major role of the teacher is to verify the occurrence of targeted educational operations and encourage the intended behaviour of students to interact with each other during collaboration. Moreover, the teacher acts as an educational facilitator, who provides guidance and allows learners to discover learning materials on their own, without interfering in their learning path in the college mathematics classroom in Ghana.

### 2.11 The Role of Student-Teachers in the Collaborative Learning Classroom

The aim of collaborative learning is to pair students or put them into small groups to find their own solutions and ideas to existing problems in order to gain knowledge and develop their professional competencies. This will make them ready to practice and undertake new activities (Alonso, Lopez, Manrique and Vines, 2005). All activities in Mathematics learning depend on collaborative learning (MOE, 2018 and T-Tel, 2016). Regarding the student experience of Students in Colleges of Education who were selected from the various colleges had different view of collaborative work. Some students believed it was positive and effective, whereas other students believed it was boring, frustrating and did not help progress in the academic process. The distinguishing element in collaborative learning is that it does not put pressure on the learners. The learners feel more comfortable which increases the educational

achievements. The role of college students through the collaborative classroom are as follow:

1. Awareness: recognizing the importance of Mathematics, performing tasks more efficiently and improving skills.
2. Orientation: the student must be prepared to deal with the different stages of the study on Algebra course during collaboration.
3. Disciplined: Assignments and projects should be completed.
4. Organized: study obligations should be followed to a time schedule.
5. Self-directed: The ability and potential to motivate. Internal or externally motivated: Prompt the students to act (Wagner, 2008).

**2.12 Collaborative Learning Approaches**

Collaborative learning covers a broad territory of approaches with wide variability in the amount of in-class or out-of-class time built around group work. Collaborative activities can range from classroom discussions interspersed with short lectures, through entire class periods, to study on research teams that last a whole term or year. The goals and processes of collaborative activities also vary widely. Some faculty members design small group work around specific sequential steps, or tightly structured tasks. Others prefer a more spontaneous agenda developing out of student interests or questions. In some collaborative learning settings, the students' task is to create a clearly delineated product; in others, the task is not to produce a product, but rather to participate in a process, an exercise of responding to each other's work or engaging in analysis and meaning-making (MacGregor, 1990).

The design of the collaborative task is crucial. There are three essential elements in designing a collaborative task. Firstly, it should not be possible to complete the task by one individual.

Secondly, the task must require the effort of all participants to achieve completion. The students should be dependent on each other for the completion of the task. Thirdly, it should not be a 'right answer' task. There should be more than one answer, so that the students could consider the possible answers and decide which is better, and the reason for one being better than the others. As the students may have been engaging in isolated and competitive learning, the teacher should explain to them the skills and expectations necessary for collaborative learning, in order to prepare them for the task. They could initially be asked to work in pairs so they develop their skills of communication. Then they could be placed in groups of three or four. Students should be advised that preparation for the discussion, by engaging in the recommended reading is important for a successful outcome of the discussion (Dirkx & Smith, 2017). When some students are not prepared for the group discussions, this causes frustration among the students who are prepared.

In designing collaborative learning there should be 'group goals' and 'individual accountability' to achieve the common goals. The collaborative learning task should ensure that each member of the group has learnt something. The teacher could divide the key concepts to be learnt and assign to each student a concept, giving them the responsibility of learning the concept and explaining to their fellow-students. In explaining to other students, they act as teacher, which experience is beneficial to them, as well as other students. Group size is important in the design of the collaborative project. If the group is too large, while active members contribute frequently to the group, the less active members do not contribute frequently. The group size should be large enough to have different perspectives, but small enough so that each member feels confident to participate in the group discussion (Dirkx & Smith, 2017). The discussion topic needs to be relevant so that students are motivated

to participate in the discussion. Some perception of students was that the quality of the collaborative environment discussion was important for the success of a group project and knowledge construction. The quality depends on whether the participants have done the necessary research, so that the discussion is evidence-based (Jianxia and Xu, 2008). In using groups in a collaborative environment, it is necessary to create the groups, structure the learning activities and facilitate group interactions. Instructors need guidance to set up and deliver instruction for their students in collaborative learning projects (Powell, 2013)

### 2.13 Reforms in Colleges of Education in Ghana

In Colleges of Education in Ghana, the nation's only state-sponsored, academically directed institution to train pre-tertiary teachers was founded as early as 1910. Colleges of Education in Ghana are a pivotal tertiary education national institution, which is the driving force in creating a future national workforce for a multitude of cutting-edge careers. Its main target is to train pre-tertiary teachers at the peak of the nation's teaching institutions, as well as to achieve a good reputation as a modern, technology driven institution that is committed to international standards of environment sustainability (Greenberg, 2012).

Colleges of Education in Ghana provided undergraduate Education degrees before 2019, and most Ghana public school educators studied and/or trained there. A degree in Education is now provided at the college levels which have the third years of the program, through which students will be able to gain a Bachelor of Education (B.Ed.) degree in Arts or Physical Education, Science, Mathematics, Vocational Skills, Agricultural Science, Social Studies among others Information, Communication and Technology. Colleges in Ghana initiated efforts to implement a new vision in

2017/2018 academic year to introduce strategies to achieve this goal. In the past, education in Ghana was associated with studying the mathematics and other Core participants in Ghana. The early establishment of Universities of Ghana was as a primarily secular institution in 1970 and then it was converted into a university with six colleges, where, in the October of 2008 more than 23,000 students enrolled. The colleges run bachelors of basic education program only (Greenberg, 2012).

It also awards various postgraduate diplomas and certificates to students who finish two to five semesters of study in specific participants. Due to the customs and traditions prevailing in Ghana, like other countries in the region that take into account the cultural and societal norms, sees teaching based on gender segregation. Thus, at Ghana, Colleges of Education, all classes and extracurricular activities are gender inclusiveness unlike the previous which was separated among the mixed gender Colleges. The teaching staff teaches both sexes. The Colleges are keen to insert new scientific sections and units, introduce its instructional plans, and evaluate the compatibility of the curriculum and program offered within their affiliate faculties and address the concerns and demands of the community. It also aims to better support staff development.

### 2.14 Main Problems of Colleges of Education in Ghana

Several reports and studies have shown that a large percentage of graduates from Ghana schools and universities prefer to work in the government sector rather than private sectors or establishing their own companies. This is so because of an incompatibility between the vocational and technical education (Weber, 2010). The graduate students from Ghana, are still not yet ready to enter the labour market with enough and proper practices or to enter innovative university disciplines (Gonzalez,

2008, p. 50). In educational institutions, males work in careers which are out of demand and contradict their major (Stasz, Eide and Martorell, 2008).

However, there are some recognized weaknesses in the current education system in Ghana. In many governmental and private schools, the curriculum is current, being based on rote memorization. There is also no suitable and general vision of education quality and the structures required to support it. The system often misses its own performance indicators, and there is no drive to connect the performance of students with school performance. Girl-child education in the area of science and mathematics at the college of education is still very low. A research on history on girl-child education, indicated that, among the science and mathematics colleges in Ghana, the number of females in these classes were not encouraging (T-TEL, 2016). Again, at the managerial positions like the students' representative council (SRC), female tutor in mathematics education, female principals and heads of various institutions, the story was same. This results bored students and offers little chance for female student-teacher interaction.

Finally, although Ghana is a middle income nation, investment in the area of national education is still modest. Teachers get little professional development and are poorly paid, and classrooms are crowded because most school buildings are badly designed. Therefore, it is clear that the reforms regarding the education system in Ghana are going in the right direction, and given the weaknesses within the Ghana education system, timely initiatives are necessary. It is against this background that the new curriculum for the pre-tertiary levels was designed. It sought to improve the standard of education in Ghana by focusing on collaborative teaching and learning among Ghanaian children. It was also to empower more women into science and

mathematics education as well as encouraging more constructivist approach to learning in all levels of education in Ghana.

### 2.15 Summary of the Chapter

The chapter examined the various related literature with respect to effects of collaborative learning on students' mathematics achievements and their gender groupings. The theoretical framework which is based on constructivists theory suggested that the learners must be placed at the centres of the collaborative learning environment. The role of the teacher in the collaborative activities had been defined, therefore tutors at the selected colleges of education in Ghana must strictly go by their role so that learners would be able create their own knowledge in the mathematics classroom. The role of the student in the collaborative learning classroom and the challenges the education system is faced with in dealing with collaborative learning in Ghana had been spelt out. Although, there were varying opinions in the role of gender in the collaborative learning environment as to which gender performs better among the various scholars whose works were reviewed, yet each was of the view that collaborative learning plays significant role in the classroom environment.

# CHAPTER THREE

# RESEARCH METHODOLOGY

## 3.0 Overview

In this chapter, the research methodology is described in detailed. It outlines and justifies the approaches and methods chosen for the study. There are different approaches to collecting data for various types of research and the current study used quantitative methods and a survey. The study investigated the effects of collaborative learning on students' gender groupings and their mathematics achievements among college students in Ghana. The research method depended on the constructivist theory of learning. Based on this, a pure experimentation was introduced for this research work.

Moreover, this chapter highlights the practical part of this study. In addition, it explained in detail how the variables included in the study model are measured. Chapter three begins with the research design which gives the reader an idea of the direction of the study. The description of the study area, study population, sample and sampling technique, instrument for data collection, data collection procedure and data analysis procedure.

## 3.1 Research Design

This study utilized the experimental research design. It investigated the effects of collaborative learning by gender groupings (independent variables) in the mathematics (dependent variables) performance of the subjects of this study which was composed of 9 groups, three groups are all male members, another three are all female groups, and the last three were mixed groups with two male and two female members for a total of 18 male and 18 female students. This study used purely

quantitative method to explore and explain the effect of collaborative learning on students' gender groupings in their mathematics achievements.

### 3.2 Study Population

The study targeted all 186 level 100 science and mathematics colleges of education students in the Ashanti and Brong Ahafo Regions (ASHBA) in Ghana. These were students who had been offered admissions into the various colleges of education in the two regions. These colleges are Agogo College of Education all female student college, Mampong College of Education all male institution, while Berekum College of education sited at Brong Ahafo region was a mixture of the two gender groupings. These were also colleges who had different affiliate universities among the public universities in Ghana. The Principals, Heads of Department of Mathematics and mathematics tutors for these institutions were all considered for the study. The various participants for the study came from Berekum College of Education, Mampong College of Education, and Agogo College of Education respectively.

### 3.3 Study Sample

The study sample was 83 male and 61 female students making a total of 144, whose ages ranged between 17 and 26 years at the time of the study. These students were all science and mathematics bias who were registered to study Basic Algebra from the three selected Colleges of Education in Ashanti and Brong Ahafo regions of Ghana. In all 83 male students and 61 female mathematics and science students were selected using simple random method. The sample was divided into three groups: All males group, all females group and a mixture of the two groups (Male and female). In other words, same gender groups and mixed gender groups.

### 3.4 Sampling Technique

A multi-stage sampling technique was used to select the participants for the study. A multistage sampling technique is a type of sampling in which the sample is drawn in many stages, and it entails the use of a combination of sampling methods in a variety of ways to address sampling needs in a more efficient and effective manner (Richard, 2009). Therefore, probability and non-probability sampling techniques were used. Under the probability sampling, stratified sampling technique was used. College students were divided into three strata namely; all males group, all females group and mixed gender group. The motive behind the stratified sampling technique was that the sample frame given consisted names and educational status. Therefore, there was the need to select a level into homogeneous sub-groups so that each stratum will contain subjects with similar characteristics such as age, sex, programme of study and educational background. Each stratum contained participants which added up to 6 participants.

Under the non-probability sampling techniques, purposive and convenient sampling techniques were employed. Purposely, the researcher administered the questionnaire to only students in the mathematics and science programs in the selected colleges. In order to have access to most of the questionnaires distributed, the researcher sent the questionnaire to the colleges and waited 45 minutes for respondents to complete them. At Mampong Technical College of Education, 80 questionnaires were administered. The total number of questionnaires administered at the Berekum College of Education were 69 and 65 questionnaires were administered at Agogo College of Education. The main purpose of the questionnaire is to extract data from the respondents. It is a relatively inexpensive, quick, and efficient way of collecting large amount of data even when the researcher isn't present to collect those responses first hand. But an

important factor to note is that a questionnaire isn't the process of analyzing the responses. The process is surveying. The questionnaire enables the research to collect information about their knowledge and about collaborative learning strategy, and the kind of gender group they preferred to work with in the mathematics classroom. These constituted the total questionnaires which were administered in the three colleges from which the sample was drawn.

### 3.5 Research Instruments

The study utilized teacher-made formative tests for their mid-semester test, collaborative learning activities constituting project works, class exercises and assignments, and an achievement test for their end of semester examination scores. Tests were conducted and item analysis was done to validate the instrument. Analysis of variance (ANOVA) was used to measure data on collaborative learning. The students were asked to fill in a questionnaire in order to distinguish their program of learning, and some were eliminated from the analysis process due to instability in their program of learning across the responses. The final sample thus constituted 144 students in the three categories.

### 3.6 Dependent Variables (Mathematics Performance)

Dependent variables are represented in students' achievements. To present the theoretical literature on the topic, the researcher depended on the following resources: Formative test, Collaborative learning activities and Achievement test. Pre-test items of 20 Multiple Choice Questions (MCQ) was administered to the students to determine their levels of understanding with the Algebraic concepts. Again, the pretest results served as basis for effective comparison with the Achievement test (end of semester post-test results) (Appendix C) as to whether or not the intervention used

was effective. A posttest items of 16 MCQ and 4 theory questions based on the course content were applied to assess and compare progress and achievement of students with different gender groupings at Colleges of Education in Ashanti and Brong Ahafo regions in Ghana (Appendix D).

### 3.7.1 Questionnaire

The researcher used questionnaire as one of the instruments because of the reasons given by some experienced researchers. Questionnaire is simply a 'tool' for collecting and recording information about a particular issue of interest. It is mainly made up of a list of questions, but should also include clear instructions and space for answers or administrative details (Stefan, 2013).

### 3.7.2 Questionnaire for Students

The students' questionnaire comprised sections on demographic data with items such as gender, age, socio-economic and cultural, college-based factors with items such as method of delivery by mathematics tutors, availability of teaching and learning materials and mathematics text books and their programs of study. Furthermore, the questionnaire contained questions on preference to learn individually, preference to learn with larger group, preference to learn with mixed gender group and preference to learn with same gender groups. This enabled the researcher gather information in order to answer research questions 1 and 2 respectively. In all there were 10 items in the questionnaire which students were guided to answer for the classification and selection into the study (Appendix B).

## 3.8 Data Collection Procedure

The one hundred and forty-four (144) participants who went through the selection process were administered with the questionnaires. The various mathematics tutors in

the selected colleges assisted in the process of administering the questionnaires. The participants were instructed on how to respond to the questionnaires and instruction read out to the participants to ensure proper filling and high response rate. The researcher assured students that their responses will be treated will the strict confidentiality. The completed questionnaires were retrieved soon after the participants have finished with their response and handed over to the researcher for analysis.

### 3.9 The Implementation of the Intervention

In the first semester of 2019, the three groups of students who were selected for the Algebra course were selected by the researcher from the Department of Mathematics/ICT of the various Colleges of Education in Ghana. Thus, one group was selected at random by the researcher as the all-males' class, a second group was selected as the all-females' class and finally, a mixture of the first two gender groups.

The three classes were taking the mathematics Course (Algebra). The only difference was gender groups. The researcher, a course tutor at a Colleges of Education in Ghana, became the instructor to the three groups. Some resources and learning supplies (books, educational links from the Internet, educational films, and PowerPoint presentations) were quickly distributed to facilitate the process. At the beginning of the research process, some demographic data were collected from students in each group according to age, college, previous senior high school grades and gender. The researcher informed all three classes of students about the study in the first meeting, and provided an information page and consent form (Appendix A), which asked them to sign if they were willing to participate. This was followed by the activity plan for the whole period of the study.

Week 1: Pretest application 16/09/2019 to 20/09/2019) to determine students' initial performance in the Algebra Course (Appendix C).

Week 2: Application of questionnaire on the choice of a learning strategy (23/09/2019 to 27/09/2019).

Week 3, the students were grouped into classes and the researcher took students through the course outline as well as actual teaching of the selected topics in the course outline:

a. All male class - collaborative work

b. All female class - collaborative work

c. Mixed gender - collaborative work

Week 4: Researcher introduced students to the various concepts and took the place of a facilitator and asked students to work on prescribed tasks based on the Algebra course in their classes. The researcher later asked the groups to report on their findings (10/10/2019 to 17/10/2019).

Week 5: Researcher continued week four work by introducing the lessons, taking the facilitator's role and asking students to collaborate to find possible solutions to the given tasks 11/12/2019 to 13/12/2019.

Week 6: Various gender groups were asked to do presentation on word problem and inequalities. Group discussions followed shortly after each of the discussions. There were prescribed laid down rules to follow during the presentations so as to have conducive atmosphere. Discourse was allowed in the group discussion so that students can freely express themselves in the learning process. In the seventh week, the researcher interacted with the students to determine their views and sensitivities regarding the teaching technique used in the Algebra Course. This followed a posttest

named quiz 2 which was done individually (Appendix D). The three classes studied the Algebra course using collaborative learning methods on Tuesdays to Thursdays from 7.00 am to 5.00 pm till 27/01/2020.

### 3.10 How the Researcher Facilitated the Collaborative Classes

In the context of the collaborative classes, the researcher carried out the following experience with the students: through a face-to-face class, terms were clarified for the students using PowerPoint slides. The researcher facilitated in all the classes by allowing the students to collaborate in the classes. Concepts and the theories were explained with examples. Each group was presented same tasks and students were allowed to collaborate and present their solutions. This went on throughout the mathematics achievement tests. Enough learning materials were provided to the students to collaborate after which students presented their group solutions. The researcher as stated already, facilitated in the learning process only during the instructional periods.

Firstly, the study explored the differences between the collaborative learning style and outcomes in same gender groupings and mixed-gender groupings. This allowed the study to compare the engagement and learning performance of same and mixed gender groups, verified the gender gap reported in (Ridge, 2009) and tried to understand its possible sources from the learning engagement patterns. Secondly, the study looked at the journeys of several students who migrated from same to mixed groups and vice-versa and observe the changes in engagement and performance throughout these migrations.

Finally, the study then tried to isolate the synergies attained through collaborative learning and assess how well these synergies will be exploited by different gender compositions of the group of students.

In the context of the three classes, the researcher carried out the following experience with the students: through a face-to-face class, terms were clarified for the students using PowerPoint slides. The researcher facilitated in all the classes by allowing the students to collaborate in the classes on the algebraic concepts. Concepts and the theories were explained with examples. Each group was presented same tasks and students were allowed to collaborate and present their solutions. This went on throughout the mathematics achievement tests. Adequate learning materials were provided to the students to collaborate after which students presented their group findings. The researcher as stated already, facilitated in the learning process only during the instructional periods.

### 3.11 Data Analysis

The mean, variance and the standard deviation were used to find the averages of the formative tests, collaborative learning activity outputs and the achievement test of the students. ANOVA was used in comparing the performance of the three collaborative learning groups in their formative tests, collaborative learning activity outputs and achievement test. After data collection, the researcher utilized the One-way analysis of variance (ANOVA) to compare student's achievements due to gender in the collaborative learning. Pretest and posttest results were also compared as whether there was a significance in the results. Version 20 of SPSS was employed to generate all statistical analysis for the study.

# CHAPTER FOUR

## RESULTS AND DISCUSSION

### 4.0 Overview

This chapter entails various stages of the analyses and reporting of the results including an overview of the selected studies. The analysis involves the mean of various gender groups in their collaborative learning, analysis of variance among the gender groups in the formative and achievement results and the major findings of the study.

### 4.1 Demographic Characteristics of Participants

The study randomly selected 83 (57.6%) male and 61 (43.7%) female participants who were offering science and mathematics at the colleges of education in Ghana. The age brackets of the students who were aspiring to become professional teachers in mathematics and science were between 17 and 26 inclusive. These were first year Bachelor of Education students majoring in mathematics and science in the various selected mathematics and science colleges in the Ashanti and Brong Ahafo regions.

### 4.2 General Study Information

The general study information includes the performance of Colleges of Education students with respect to the effects of collaborative learning in the mathematics classroom based on their gender groupings. The students were given pre-test questions as a diagnostic test to determine their output level with regards to the semester 1 Algebra course. The mean, standard deviation and the variance of their scores were therefore analyzed and presented in Table 4.1

**Table 4. 1 : Report on Students Pre-Test Results**

| Means | All Males | All Females | Mixed Groups |
|---|---|---|---|
| Mean | 8.00 | 6.60 | 3.60 |
| Std. Deviation | 2.00 | 1.84 | 2.16 |
| Variance | 1.42 | 1.35 | 1.47 |

The summary from Table 4.1 shows that the all male students performed better in the pretest exams than the other groups when grouped alone with a mean mark of 8.00 with a standard deviation of 2.00 which variance was 1.42. The all female group had a mean score of 6.60 and a standard deviation of 1.84 whose variance was 1.35. Mixed gender group recorded the least mark per the pretest analysis of a mean score of 3.60 and a standard deviation of 2.16 and a variance 1.47 respectively. These results were obtained before the implementation of the model (Collaborative Activity).

### 4.3 Students' Formative Test, Collaborative Activity and Mathematics Achievement Mean Scores

During the study, the selected students were assessed by the researcher as part of their continuous assessment for the colleges and the mean of scores at the end of semester results calculated. The mean mark obtained by all gender groups are presented in Table 4.2 with regards to Formative test, Collaborative Activity and Mathematics Achievement Results.

**Table 4.2: Students' Formative Test, Collaborative Activity and Mathematics Achievement Test Mean Scores**

| Group/Activity | Formative Test | Collaborative Activity | Mathematics Achievement Test |
|---|---|---|---|
| | Mean | Mean | Mean |
| All Male | 20.01 | 31.23 | 38.41 |
| All Female | 19.32 | 34.54 | 35.01 |
| Mixed Group | 17.41 | 32.52 | 33.81 |

The results from Table 4.2 shows that the All-male group performed better than the All-female group and the Mixed gender group in the formative test with a mean score of 20.01, while all female and mixed groups scored a mean mark of 19.32 and 17.41 respectively. Reasons could be that boys would want to work independently when it comes to task analysis as compared to girls and also when mixed together. In the Collaborative results, all female group performed better with a mean mark of 34.54 than the All males mean of 31.23 and mixed gender groups mean of 32.52. The results showed that girls seemed to collaborate better in same gender group during the learning process than all boys and also when put together with boys as compared to All boys put together during collaborative learning. In the students Achievement mean test, the All male students had the highest mean of 38.41 greater than all female mean score of 35.01 and mixed gender group mean score of 33.81. These were much improvement on the pretest mean score. These were the results during and after the implementation of effective collaborative activities in the various groups.

The results implies that all male groups performed better than the all-female group when working together in same gender, while female students working with female students performed better when they collaborate as compared to if they were grouped

with boys and all boys in same group. Collaborative learning and gender groupings might have affected the performance of the students in their achievement test.

### 4.4 Students' Collaborative Learning Activity

The results of students were discussed and analyzed to find if collaborative learning had effect on the scores of the gender groupings in their Formative Test. The ANOVA Table 4.3 provides the results.

**Table 4.3: ANOVA of Students' Collaborative Learning Activity**

| Collaborative Learning Activity | | | | | |
|---|---|---|---|---|---|
| Groups | SS | df | MSS | F | Sig. |
| Between Groups | 6.43 | 2 | 3.22 | 2.80 | .064 |
| Within Groups | 162.06 | 141 | 1.15 | | |
| Total | 168.49 | 143 | | | |

Table 4.3 presents the collaborative activities among the three gender groupings which shows that the set significant value of $\alpha = 0.05$ is less than the calculated value of $Sig. = 0.064$. This value indicates that, there is a significant difference in students' collaborative Activity. The result is in line with the alternative hypothesis that there is a significant difference in the collaborative activity in the three different gender groups. This result implies that if tests are taken the scores of the subjects will differ significantly with respect to gender groups if collaborated in the learning activities.

### 4.5 Students' Formative Test

Students test scores were collated and results analyzed in the ANOVA Table 4.4 to determine whether there was significant difference in students formative test among the three gender groups.

**Table 4.4: ANOVA of Students' Formative Test**

| **Formative Test** | | | | | |
|---|---|---|---|---|---|
| Groups | SS | df | MSS | F | Sig. |
| Between Groups | 26.389 | 2 | 13.194 | 5.133 | .007 |
| Within Groups | 362.438 | 141 | 2.570 | | |
| Total | 388.826 | 143 | | | |

Table 4.4 shows that, the Sig. = 0.007 less than $\alpha = 0.05$ revealing that there is no significant difference in the students' formative test. The result confirms the null hypothesis that there is no significant difference in the formative test of students among the three different gender groups. It implies that students' gender has no influence in their mathematics achievement.

### 4.6 Students' Achievement Test (Posttest)

Students' posttest scores were collated and results analyzed in the ANOVA Table 4.5 to determine whether there was significant difference in students' mathematics achievement among the three gender groups.

**Table 4.5: ANOVA of Students' Achievement Test (Posttest)**

| **Achievement test** | | | | | |
|---|---|---|---|---|---|
| Groups | SS | df | MSS | F | Sig. |
| Between Groups | 586.35 | 2 | 293.17 | 11.15 | .000 |
| Within Groups | 3707.98 | 141 | 26.30 | | |
| Total | 4294.33 | 143 | | | |

Table 4.5 presents the posttest results in the three gender groups with the computed $Sig. = 0.000 < \alpha = 0.05$ reveals that there is no significant difference in students' achievement test results with regards to students' gender groupings. Implying gender did not play any significant role in students' mathematics achievement test. The

result confirms the null hypothesis stating that, there is no significant difference in the mathematics achievement test of students in the three different gender groupings.

### 4.5 Analysis of Questionnaire Reports

The questionnaire sent to the participants for the study were retrieved and analyzed and results presented in the Bar Chart in figure 1.

#### 4.5.1 Bar Chart Showing Questionnaire Results

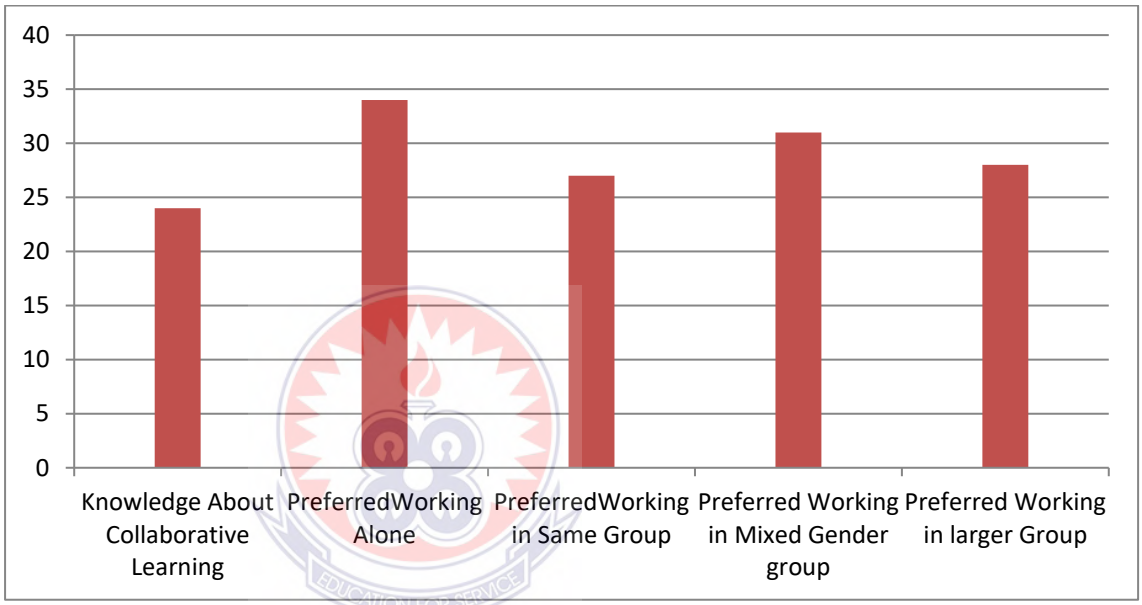


Fig 1.

From figure 1, 24 students from the various Colleges representing 16.67% were of the view that they have knowledge about collaborative learning. 34 of the participants representing 23.61% preferred working alone in the classroom since they thought it was the fastest way of achieving results. This formed the basis of the study. Again 27 students representing 18.75% of the participants of the study preferred working in same active groups. 31 of the participants, representing 21.53%preferred working with mixed gender groups. Finally, the data had it that 28 students preferred working in larger groups during class work. This represents 19.44% of the total participants

### 4.6 Answering the Research Questions:

**1. What is the performance of the students in employing collaborative learning activities?**

The study's main findings reviewed that there was a significant difference in the achievement and skills of the gender groupings who collaborated in the learning process. This difference was seen in their formative test, collaborative learning activities and mathematics achievement tests. It was observed that students performed differently, when they worked with same group as against when they are mixed. The mean score of students' formative test indicated that the male group had the highest mean followed by all female group and then mixed grouping. Results on the students' collaborative mean scores reveal that collaborative learning had a significant effect on the students' mathematics scores among the all-male group, all female group and the mixed group. This effect concurs with the findings of many previous studies: for example, (Waring and Evans, 2014) stated that students must engage with each other, especially on long-term tasks, in order to gain more knowledge and share ideas, which will make them learn better as put in groups. It also supports (Gulbahar and Alper, 2011) finding that most learners have different learning styles based on their individual characteristics, and thus prefer to choose facilitating and learning situations and interactions among students they can trust in the learning environment, especially in collaborative learning environments.

Moreover, the study also agrees with Gulbahar and Alper (2011) also found that learners prefer collaborative learning in synchronous learning activities such as exercises and exams. Moreover, this study disagreed with Lee and Kim (2014), who found that most Korean students did not prefer collaborative learning styles. The study also found that most students prefer diverging and assimilating learning

programs during problem solving logical reasoning to converging and accommodating styles during the implementation. The study also found that girls prefer working with same gender during collaborative learning activities as compared to working with the opposite sex. This concurs again with (Shen, Hiltz and Bieber, 2008) who found a significant relationship between collaborative learning and students' exam scores, as their collaborative class achieved higher exam scores during collaboration activity.

Additionally, (Frey and Kaff, 2014) in a study focusing on a comprehensive school, found a positive effect of course content and teaching in collaborative learning on the post-course knowledge of students in terms of awareness of the school's practice for students with disabilities and enhancing their knowledge.

Also, the present findings agree with the results reported by (Hassan, Fong and Idrus, 2012) which showed a significant difference on posttest scores between students collaborative learning activity and their mathematics achievement. Again, Yang, Woomer and Judith, (2012) found a positive significant effect in the collaborative learning of students who used a digital game-based learning strategy in terms of improvement in their problem-solving skills. The present findings also agree with (Hassan, Fong and Idrus, 2012) who found that scores on Arabic language achievement for students on their collaborative learning were significantly higher than their pretest score. Moreover, Zhu (2012) indicated that collaborative learning might improve not only the total group performance, but also class performance, through raising the quality of tasks completed, such as improving the formulation of ideas and opinions. Zhu also found that collaborative learning increased the learning activities for knowledge construction by class interaction.

In addition, (Cashs, 2013) showed that students undertaking collaborative learning scored significantly better in their posttest than their pretest results. The present findings also agree with (Essaid, Horwitz and Chiarizia, 2011) who found a significant difference in posttest scores between students using collaborative and their pretest results, and as such students after engaged in collaborative learning achieving higher scores. They also found a significant difference between learning achievement and performance. There was a positive relationship among students' collaborative learning activity and students' achievement test in the mathematics learning environments. From the analysis, it was observed that collaborative learning enabled students with low abilities to improve their knowledge of tasks, which led them to increase their grades in the posttest (Azani, 2010). In addition, Azani indicated that all students in their study believed that collaborative learning would improve their achievement test better than before. Furthermore, results by (Khan, 2013) indicated that collaborative learning improves students' empowerment in a learning environment.

In addition, (Barnes, 2000) found that some students stated that the collaborative learning develops and improves their interpersonal skills, while others showed negative attitudes towards collaborative learning because they did not have enough ability to collaborate well in groups without direct intervention. A positive significant difference was also found in achievement test scores among all three groupings as well as the collaborative activities and mathematics achievement test. The collaborative activities were manifested in all the results of the three groups. This was to say that collaborative learning had significant improvement on the performance of students in the mathematics class irrespective of one gender.

**2. What is the performance of students in the same group and mixed gender grouping using collaborative learning activities?**

From the above results, the main finding was that there were significant differences in the students' collaborative learning activities among the three gender groupings. Thus, there was an effect on the collaborative activities the ANOVA results did not provide significance in the formative test and achievement test of scores of students engaged in collaborative learning activity with the same gender and mixed gender groupings. On the other hand, differences in gender groupings did not hinder the effect of progression and the performance of students in their collaborative learning environments. This effect concurs with the findings of numerous previous studies. For example: In order to examine the effectiveness of gender composition on collaborative learning, (Ding, Bosker and Harskamp, 2011) randomly paired participants with a same-gender or an opposite gender partner to overcome a number of structured problems related to Newtonian mechanics across two weeks. The comparison of the pretest and posttest scores demonstrated that all participants who collaborated with others improved in their group posttests results.

Despite this improvement, it was criticized that this might be due to more practice sessions offered for collaborative participants than if they worked alone during the two weeks. Most importantly, the result further found that male participants performed identically well in both same-gender and opposite-gender groups. Bosker and his colleagues observed that boys reacted equally active no matter what gender they were paired with and, perhaps, this consistency of communication style leads them benefit from collaboration regardless of gender composition. This confirms the position of the current study that there was a significant difference in students' posttest results as compared with the pretest score.

Again, the current study agreed with (Duveen and Psaltis, 2006) who assigned boys to work with either more-able males or more-able females so as to solve a task of conservation of liquid. According to them, learning improvement was assessed by their pretest and posttest differences. From their findings, boys who interacted with girls improved the most compared to those grouped with boys/boys. This finding was also confirmed in the current study looking at the mean score for all male students as against the all female and the mixed gender groups in their pretest results, formative test, collaborative learning activity and the achievement test results.

Additionally, unlike Bosker and his colleagues' observation, Duveen and Psaltis found that gender composition is likely to influence the type of conversation that boys used in their discussion. Boys were more likely to disagree with their female partners than their male peers in group discussions. This is in line with Piaget's idea that boys with female partners are thus likely to re-examine their initial knowledge cognitively and need to recognize a higher order solution to the problem which resolve the apparent conflict. Hence, they may understand more and improve more eventually from collaboration. By contrast, as there was less disagreement, this socio-cognitive process is less likely to be generated in boys who interacted with other boys and hence they may improve less. Nonetheless, rather than seeing the two studies as contradictory, this is better to perceive the current research as an extension of Bosker and his colleagues' one. That is, other individual differences, such as ability, may interact with gender composition in influencing the effectiveness of collaborative learning.

Moreover, a number of studies have shown that distinct gender composition may impact learning effectiveness in girls (Ding, Bosker, & Harskamp, 2011). Secondary school girls were grouped with males or females to overcome moderate physics problems in a two-week experiment. By comparing their group pretest and posttest scores, girls with other females outperformed their counterparts who worked with males. Similar result was documented by Ding and Harskamp (2006) who recruited Chinese students in Shanghai.

These findings are thus culturally valid for demonstrating that, unlike boys, gender composition matters to girls and single-gender is superior to mixed-gender for girls as proven by this study. This was observed in all the results that all girls group outperformed those who mixed with boys in the colleges.

Underwood and Underwood (1996) observed that girls who interacted with same-gender group mates were more likely to joke and laugh with each other, therefore they were less stressful in the conversation compared to those in mixed-gender composition. This finding was rejected by the current study. This observation is further elaborated by (Berdondini, Kutnick and Ota, 2008) through the idea of spring. While same-sex girls feel less pressure, they are more likely to build trust with and support each other compared with mixed-gender group. This positive interpersonal relationship therefore leads these girls to respect each other's opinions more and facilitates the establishment of common consensus emphasized by Vygotsky. This observation supports the current study that, all female group had the highest mark as compared with the all male and mixed groupings in the collaborative activities assigned during the study.

Thus, this superior peer collaboration led to a more outstanding learning outcome in girls interacting with same-sex peers than interacting with mixed-sex group mates. Nevertheless, (Barnes, 2000) found that boys' dominance significantly reduced when they participated in a language task compared to a computer-based task and Mathematics courses. This may imply that boys have greater dominance in areas that they are more interested in or talented at. This again suggests that other elements, such as task nature in this case, may interact with gender composition in influencing the effect of peer collaboration on learning. The study agreed with Barns since, boys in the mixed group in the collaborative learning according to the findings of the results performed better in their collaborative activities than when in same gender groups.

To conclude, evidence from the study suggests that collaborative learning does not benefit everyone identically and how much each group can benefit from it varies according to multiple factors such as gender differences. Nevertheless, contradictory results were found. Some studies demonstrated that boys' learning outcomes improve more than that of girls, whilst other research documented that girls outperform boys. Hence, this means that, perhaps, a child's learning effectiveness cannot simply be interpreted by his or her gender, but rather the context of participation such as gender composition. It is found that boys' benefit from both same-gender and mixed-gender groups while females only benefit from the same-gender group.

However, it is criticized that the mixed-gender group can be classified into balanced and imbalanced gender ratio compositions. As a result, females tend to benefit from same-gender and balanced ratio groups while males' benefit from all sorts of gender ratio compositions. Again, it needs to be aware that the effect of peer collaborative

learning may be impacted by the ability differences between group mates as well as the nature of the task.

Lastly, all these findings provide significant implications for schooling in the Ghanaian context in order to improve students' learning in the mathematics classroom in the colleges of education in Ghana.

**3. How will gender grouping affect students' mathematics achievement at the College of Education in Ghana?**

Answering the research question 3, with respect to whether students' gender grouping affect their mathematics achievement at the colleges of education in Ghana, the main finding was that there were no significant differences in the students' formative test and achievement test scores as indicated in the ANOVA. However, the results showed a significant difference in the collaborative learning activities. While all females collaborated better than all boys and mixed groups, all male groups had better test score than the all female groups and the mixed group in the formative test and the achievement test scores. Thus, there was an effect on the collaborative learning activities with regards to students' gender grouping as indicated in the ANOVA. However, the results from the formative test and achievement test in the respective ANOVA tables did support the null hypothesis that, there was no significant difference in students' formative test and achievement test results.

On the other hand, differences in gender groupings did not hinder the effect of progression and the performance of students in their collaborative learning environments. This again confirms with the findings of numerous previous studies such as (Ding, Bosker and Harskamp, 2011). The comparison of the pretest and posttests results is the clear indication that all participants in the three collaborative

gender groupings improved in their group posttests results. Most importantly, the result further found that all three groups performed identically well in the end of semester test scores. This improvement in their posttest results is as a result of the effective collaborative learning strategy put in place to facilitate the learning process. The finding was also confirmed in the current study that comparing the hypotheses, there was significant difference in the collaborative learning activity. Some studies demonstrated that boys' learning outcomes improve more than that of girls, whilst other research documented that girls outperform boys.

However, findings from the current study can conclude that, gender does not play any significant role in College of Education students' mathematics achievement. Rather, good gender composition and implementation of effective collaborative activities yields positive mathematics achievements.

### 4.7 Findings

Based on the results, though the three gender groups obtained different means in their formative tests, collaborative activity and end of semester results, the differences were very minimal, negligible enough to say that all students under study performs similarly when working in groups. In the collaborative learning activities, the three gender groups obtained high differences in their mean as compared to their pretests results, where the all-female groups performed better than the all-male groups and the mixed group. It was also observed from the results that all female students' group, collaborated better than the other two counterparts. It can be concluded that female students when grouped together turns out better results than all male students grouped together.

The mean scores of the three gender groups in their end of semester test given after the experimentation, tells that the all-male group obtained the highest mean score, followed by the all-female groups and then the mixed gender group. This showed that gender does not play any major role in students' mathematics learning in the mathematics classroom. However, on the statistics of the results, the following conclusions were drawn:

There was no significant difference in the mean scores obtained by the three gender groups in their formative test, probably because the students under study have similar abilities when working together.

There was a significant difference in the mean of the collaborative learning activities in the three gender groups, because performance of collaborative learning activities depends on who do we work with and how do we work together.

The mean in the mathematics achievement test of the three gender groups varies significantly due to the effect of the collaborative learning activities. This effect concurs with the findings of many previous studies. For example, (Waring and Evans, 2014) stated that students must engage with each other, especially on long-term tasks, in order to gain more knowledge and share ideas, which will make them learn better than they would if working individually.

Gulbahar and Alper (2011) also found that learners prefer collaborative learning in synchronous learning activities such as assignments and exams. In light of the literature above, the major findings of the study had shown that, students achieve more when they study with peers and are also put into small groups with people they want to work with. It was observed that collaborative learning enables students to be self-confident, very independent, more critical thinkers, create in them the relevant

leadership skills, problem solvers and develop in them their holistic cross-cutting abilities and are able to develop their core competencies in the mathematics classroom.

However, the study demonstrated that collaborative learning becomes ineffective when students are taught in whole class.

It was also observed that collaborative is ineffective when the convectional way (traditional method) is used.

Again, collaborative is weaker when students are put into bigger groups.

Finally, the findings of this study are a clear demonstration of good results when collaboration is done the right way.

**4.8 Summary**

This chapter introduced and explored the major quantitative findings of the study, providing detailed descriptions of the results for the hypothesis in addition to tabulated data. It had also presented the results of the questionnaire in order to support the quantitative results. Throughout the chapter, it has been shown that collaborative learning has positive effect on most class tasks. Collaborative learning had a significant effect on the students' collaborative activities such as presentations, assignment, group work and project work.

The study showed also that when all girls are grouped together for a mathematics task, they collaborate better than their opposite male counterparts and when mixed together with male counterparts. Moreover, there was a significant difference in the students' pretest and posttest scores in a mathematics learning environment where collaborative learning occurred.

In the students' formative and achievement test, the results showed that all male group performed better than the all female group, and when group with girls as compared to when they work in all male group. The study finally showed from the results that collaborative learning will have no significance on students' performance in the mathematics classroom if not well implemented. Again, the finding reviewed that gender does not play any significant role on students' mathematics achievement.

Finally, collaborative learning did not depend solely on gender grouping but its effective implementation and monitoring in the College of Education classroom in the selected Colleges of Education in Ghana.

# CHAPTER FIVE

## SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

### 5.0 Overview

This chapter introduces a summary of the study results and provides conclusions based on these results, as well as recommendations and suggestions for further research based on the obtained findings.

### 5.1 Summary of the Study

This study set out to establish the effect of including collaborative learning in the first year first semester mathematics course (Algebra) at the Colleges of Education in Ghana on the achievement of students with same and mixed gender groupings. The key problem of the study can be summarized in answering three main questions:

- What is the performance of the students in employing collaborative learning activities?
- What is the performance of same and mixed gender groupings using collaborative Learning activities?
- How will gender grouping affect students' mathematics achievement at the College of Education in Ghana?

This study answered the research questions through adopting an experimental approach and using mixed methods, represented in questionnaires and to collect the required data. The first stage was the process of collecting and analyzing quantitative data to address the two questions studied. Also, the study sample consisted of a hundred and forty-four students at the Colleges of Education in Ghana, with equal numbers for each class, represented by thirty-six students formed each of the three

classes. In order to get more accurate results through comparing symmetric classes in terms of the numbers of students in each class, the classes' well further sub-divided into smaller groups of four for the collaborative activities. For accuracy, each class was subdivided into four groups with nine members each forming the collaborative learning groups.

### 5.2 Summary of Study Findings

In this study, the independent variable was whether the teaching method used collaborative learning (collaborative/group work versus Mathematics achievements). The adoption of collaborative learning was applied within a first year first semester mathematics course.

In this study, the limitations were presented by the questionnaire distribution, particularly given that the target sample were made up of students at Colleges of Education levels in Ghana who offered Mathematics and Science as major program of study in the randomly selected colleges. The researcher faced difficulty in the process of reaching students and then asking them for their help, and it required official effort. The results obtained from the current study introduced an initial exploration of collaborative learning in Colleges of Education in Ghana. The sampling approach for this study depended on responses from students in Colleges of Education in Ghana. One limitation of this study was that the researcher had to accept teaching time table from the selected colleges. This made it very difficult for the study.

Thus, due to the fact that these participating individuals came from different areas in Ghana and were scattered, researching them was very difficult. Further limitations of this research could be summarized as the negative impact of collaborative learning on students' achievements because of the prevailing thinking and beliefs instilled in

students. This was because, some participants according to the various literature reviewed believed it was time wasting. The last limitation the study faced was the misconception that some teachers in the colleges had. Some believed, the researcher was a permanent staff, others believed it was the researcher's personal thing and would not cooperate, although the purpose of been there was communicated.

### 5.3 Research Contributions

This study plays a significant role, contributing to knowledge by presenting original results from Colleges of Education and the National Council for Tertiary Education system and enhancing the learning process through the progression of students' knowledge and practical skills. It also proposes ideas about how collaborative learning can have an impact on education in general.

The education sector is considered crucial in achieving sustainable development goals, which is an essential requirement of any reform process related to upgrading the community and its components, and has become necessary for pre-service teachers, tutors and stakeholders to use teaching techniques such as collaborative learning in their classrooms to unearth learner's skills and knowledge. Thus, the issue is obviously relevant to teachers, researchers, and individuals. To conclude, the education process must be developed in an integrated manner and with a comprehensive outlook, and the search is thus beginning for modern teaching and learning methods. Thus, it is more advantageous to challenge long-term education prospects in order to contribute to the creation of a strategic plan.

## 5.4 Recommendations

In light of the study's results and findings, the following recommendations were made:

1. The attention of principals and Mathematics tutors at colleges of education in Ghana should be drawn to the need to improve educational skills and competencies, including understanding of the use of effective tools such as collaborative learning in Mathematics classroom.
2. Principals of the colleges of education as well as Mathematics tutors must ensure collaborative learning like critical thinking and problem solving happen to all pre-service teachers at the 46 public colleges in Ghana.
3. Collaborative learning success stories need to be published and communicated to all schools in Ghana by colleges of education Mathematics tutors.
4. Colleges of Education strategic plans and policies should be directed towards overcoming any restrictions or weaknesses in the tools used in educational skills and competencies, and towards providing the freedom for students to choose their learning groupings by the mathematics tutors.
5. Tutors in colleges should focus on giving motivational encouragement and support to learners in collaborative learning. This may also help to harbor positive attitudes and allow for more interdependence and social interaction between group members in different mathematics learning environments.
6. More peer groups must be formed by the mathematics facilitator in the learning process for students to come out boldly to share what they can do better within their collaborative groups.
7. It was also observed in the results that, collaborative learning itself is ineffective to the learner unless it is implemented successfully to yield the desired results by the mathematics tutor.

8. Moreover, Colleges of Education tutors must function as facilitators in the mathematics learning environments. This will provide the learners the opportunities to explore new ideas, theories and concepts, share with peers and become better and independent of their own learning. This will make the learner responsible, place great emphasis on their role as leaders during collaborative activities and increase their confident levels in the classroom. In fact, this is very important because, the pre-service teacher at the college level needs these skills to be able to guide the learner to learn and achieve the required results.

In light of the results and findings, the researcher concludes that it is essential to conduct more research that aims at filling some of the gaps in this area. In particular, it is important to focus on barriers and constraints to collaborative learning that could affect students, with regards to private Colleges of Education in Ghana.

Moreover, further research is required to create proper measures that concentrate on characteristics of collaborative learning. In addition, it might be valuable for researchers to conduct research on the other colleges who offer non-Science and Mathematics programs. Future researchers should investigate the use of collaborative learning and complete tasks through other mathematics areas by comparing collaborative learning (learning in groups) and individual learning, or research on learning style preferences that influence the originality of learners in different courses and disciplines.

As a result, to improve the achievement of students as well as the quality of the collaborative learning in the future, teachers should conduct research on students' needs and difficulties and be willing to change some of the teaching and learning

contexts in line with students' abilities and regarding different contexts, such as academic and professional development services.

In sum, more research is required to shed light on collaborative learning issues that might be encountered by students and colleges of education and might limit their involvement, particularly in Ghana.

### 5.5 Conclusion

First, it has become an important step for all colleges of education institutions to adopt the most suitable approaches to encourage and support students in their learning. As this study has demonstrated, collaborative learning represents one of the effective approaches that should be introduced. However, a suitable environment must be put in place to facilitate this adoption. Gender could play a significant role, as seen in the present study. Students in the colleges of education in Ghana see collaborative learning as appropriate for some tasks, but in other contexts they prefer individual work. This is related to gender and the way they have been raised by their families and schools.

A further important conclusion is that the combination of collaborative learning and mathematics achievements has a good and positive effect on students, as they become more enthusiastic and interested. This sheds light on the importance of combining mathematics with modern education strategies.

Another element that was observed to have a positive impact and really make a difference in collaborative learning is the students' mixed groups, which reflects a cornerstone in affecting their behaviour when they work together, and thus affects their achievement. In future, this could be a turning point for collaborative learning and other learning strategies. Therefore, the best approach for improvement is to

continue to evolve through improving the understanding of such strategies in order to identify the strengths and weaknesses in the application of the collaborative approach. These factors are also important in addressing the contents of the entire system, such as problem solving, equality, gender equity, collaborative pedagogy and critical thinking.

# REFERENCES


Achuonye, K. A. (2010). A comparative study of problem-based and lecturebased learning in secondary school students'. *International Journal of Science and Technology Education Research*, Vol 1(6) 127.

Adem, U. Sehnaz,B., Goktalay. S.I., Oncur, Aysan, S. (2012). Analyzing Learning Styles of Students to Improve Educational Practices for Computer Literacy Course. *ScienceDirect*.

Ajax, G. K.B., Akhilesh. (2007). Interplay Among innovativeness, Cognitive Intelligence, Emotional Intelligence and Social Capital of Work Teams. *Emerald Group Publishing Ltd*.

Alonso, F., Lopez, G., Manrique, D and Vines, J.M. (2005). An instructional model for web-based e-learning education with a blended learning process approach . *British Journal of Educational Technology*.

Anderson, H. (2014). Impact of Collaborative Learning on students MathemTICS. *American Journal of Mathematics*.

Annelies, R. (2015). The impact of "computer-supported collaborative inquiry for science learning in secondary education. *Universitiet Gent*.

Asiedu-Addo, S. K., Assuah, C.K., Yarhands, D.A., Yakubu. ( 2016). Primary School Mathematics Teachers' Ideas, Beliefs, and Practices of constructivist instructional Strategies. *African Journal of Educational Studies in Mathematics and Science*, 4-6.

Atkins. (2010). Collaborative and self-generated analogies in science edcuation. *Journal of Science Education*, Volume 49.

Awayiga, J. W., and Tsamenyi, M. (2010). Knowledge and Skills Development of Accounting Graduates. *International Association of Decision SCiences*, 12.

Azani. (2010). The Impact Of Collaborative Learning On Students' Writing. *American Society for Cell Biology*.

Barbara, J. D. (2017). Group concept mapping: An approach to explore group knowledge organization and collaborative learning in senior medical students. *Medical Teacher* , Vol 39.

Barnes, T.J., Joiner, K., Keogh, T., Littleton, K. (2000). *Effects of dominant and subordinate masculinities on interactions in a collaborative learning classroom.* Greenwood: Greenwood Publishing Group .

Barnes, T. J. (2000). How gender Pairings Affect Collaborative Problem Solving in Social Learning Context:the Effects on Performance, Behavior and Atittudes. *journal of Management*.

Bassok, M., Chi, M.T., Lewis, M.w., Reimann, P., Glaser, K. (1989). Self-explanations: How students study and use examples in learning to solve problems. *American Psychological Association* .

Berdondini, L, Kutnick, P., Ota, C. (2008). Improving the effects of group working in classrooms with young school-aged children: Facilitating attainment, interaction and classroom activity. *Learning and Instruction 18(1):83-95*.

Bjekic, D. K. (2010). Teacher Education from E-Learning to Teacher: Master Curriculum. *Journal of educational Technology*, 201.

Bower, M., Richard, D. (2006). Collaborative learning: Some possibilities and. *Proceedings of the 23rd annual ascilite conference: Who's learning? Whose technology?*

Brindley, J.E.,Christine, W., Lisa, M., Blachke, L.M. (2009). Creating Effective Collaborative Learning Groupsin an Online Environmen. *1InternationalReview of Research in Open andDistance Learning*.

Buchs, C. , Butera, F. (2004). Socio-cognitive conflict and the role of student interaction in learning. *New Review of social Psychology*.

Cashs. (2013). Effects of CollaborativCollaborative Middle School Geometry Through Blogs and Other Web 2.0 Technologies. *Association for the Advancement of Computing in Education*.

Chief Examiner's report. (2014). UCC Builds Capacity Of Colleges Of Education Tutors. *UCC*.

Chiu, C. (2004). Evaluating System-based Strategies for Managing Conflicts in Collaborative Concept Mapping. *Journal of Computer Assisted Learning*.

Coe, R., Wiley, Bekker, L.G., Coleman, L. (2019). Organisational best practices towards gender equality in science and medicine. *National Library of Medicine*.

Cohen, E. (1994). Restructuring the Classroom: Conditions for Productive Small Groups. *Review of Educational Research*.

Cohen, E. (2020). How Gender Pairings Affect Collaborative Problem Solving in Social-Learning Context. *Educational Technology & Society*, vol 23.

Coleman, L., Charles, D.L., Wendell, P. (2000). Sixteen years of collaborative learning through active sense-making in physics (CLASP) at UC Davis. *American Journal of Physics*.

Covington, M.V., Barabara, O. (2016). Gender-Responsive Strategies Research, Practice, and Guiding Principles for Women Offenders. *National Institute of Corrections*.

Culbertson and Edgar, J. A. (2010). Collaborative Learning, Gender Groupings and Mathematics. *Journal of Research in Applied Mathematics*.

Davidson, N. (2014). Boundary Cossings: Cooperative learning, Collaborative learning, and problem-based learning. *Journal on Excellence in College Teaching*, 7-8.

Dillenbourg, P. (1999). What do you mean by collaborative learning? *Citeseer*.

Ding, N., Harskamp,E.G. (2006). Structured Collaboration versus Individual Learning in Solving Physics Problems. *International Journal of Science Education* , Volume 28, 2006 - Issue 14.

Ding, N., Bosker, R.J., Harskamp,E.G. (2011). Exploring gender and gender pairing in the knowledge elaboration processes of students using computer-supported collaborative learning. *journal homepage: www.elsevier.com/locate/compedu*.

Ding, N., Xu, B. (2008). A holistic lexicon-based approach to opinion mining.*: Proceedings of the 2008 International Conference on Web Search and Data*

Dirkx, J.M., Smith . (2013). Online Collaborative Learning Activities: The Perceptions of Culturally Diverse Graduate Students. *Turkish Online Journal of Distance Education*.

Dooly, M. (2008). Understanding the many steps for effective collaborative language projects. *Language Learning Journal* , 36(1).

Draper, S. (2004). The Effects of Gender on Grouping and Learning Style on Students Curiousity in Modular technology Education Laboratories. *Virginia Polytechnic Institute and State University*.

Duveen, G., Charles, P. (2006). Social relations and cognitive development: the influence of conversation type and representations of gender. *European Journal of Social Psychology*.

Dymitr, R. (2014). Does Gender Matter for Collaborative Learning? *Conference: IEEE International Conference on Teaching, Assessment and learning for Engineering*.

Essaid, Horiwitz, E., Chiarizia, Dietz, L.M. (2011). The Impact Of Collaborative Learning On Students' Writing Ability And Their Motivation In Writing At MTs Negeri 1 Konawe. *Journal of Language Education* .

Felder, R. M., Brent, R. (2007). Effective Strategies for Cooperative Learning. *ResearchGATE*.

Filardo, Bearison. (1996). Constructive Activity and Learning in Collaborative Small Groups. *Educational Psychology*.

Finkel, D. L., Monk, G.S. (1993). Teachers and Learning Group. *San Francisco: Jossey-Bass*.

Frey, L. M., Kaff.M.S. (2014). Results of Co-Teaching Instruction to Special Education Teacher Candidates in Tanzania. *The Journal of the International Association of Special Education*.

Goldstein, J. Puntambekarr. (2004). The Brink of Change: Gender in Technology-Rich Collaborative Learning Environments. *Journal of Science Education and Technology*, 13(4).

Golub, J. (1988). focus on Collaborative Learning Classroom Practices in Teaching English. *Kenyon Rd*.

Gomathi, S., BMalamaham,P., Tech, M. (2015). Emotional Intelligence - Its Importance and Relationship with Individual Performation, team-Effectiveness, Leadership and Marketing Effectiveness. *Meditarrenean Journal of Social Sciences*.

Gonzalez, G. (2008). Facing Human Capital Challenges of 21st Century: Educational and Labour Market Initiatives. *Santa Monica Rand Corporation*.

Greenberg, A. (2012). QBlended Learning and the College of Pharmacy. *Wain House Research Paper*.

Gulbahar, Y. A. (2011). Learning Preferences and Learning Styles of Online Adult Learners. *A. Méndez-Vilas (Ed.)*, 3-4.

Guzzetti and Williams, T. (2008). Technology in the Classroom: Burning the Bridges to the gap in gender Biased Education. *Sciencedirect*.

Hall, M. (2008). The Effect of Cooperative Learning Groups and Competitive Strategies on Math Facts Fluency of Boys. *Kennesaw University* .

Hassan, M. A., Fong, S.F. (2012). Conceptual and socio-cognitive support for collaborative learning in videoconferencing environments. *British Journal of Educational Studies*.

Hayes and Allinson. (2015). Exploration and Exploitation within Firms: The impact on Increnental and Radical Innovation Performance. *Wiley Online Library*.

Hein, T.L., Budny, D.D. (1999). Teaching to students' Learning Style: Approaches that work. Proceedings of 1999 . *Frontiers in Education Conference, Session 12 C1,* , 7-14.

Hwang, R. (2008). Cooperative Learning in Passive Learning Environment: Application and Extension. *American Accounting Association*.

Jianxia, D., Jianzhong, X. (2008). Online Collaborative Learning and Communication Media. *Mississippi State University, United States*, Volume 19, Number 1.

John-Steiner, V., Wbber, J.W, Minnis, R. (1998). The Challenge of Studying Collaboration. *American Educational Research Journal 35(4):773-783*.

Jones, A. a. (2010). Collaborative and self-generated analogies in science education. *Journal of studies in science education*, Volume 49, Issue 1.

Jones and Atkins. (2010). Collaborative and Self-generated analogies in science education. *International Journal of Science Education*, 4.

Khan, H. (2013). Use of e-learning tools to solve group work problems in higher education: A case study of Gulf country. . *Advances in computer science* , 3.

Kim, E. (2017). Gender and the Sustainable Development Goals. *SAGE Journals*, 4.

Kirk, Florence, R, Spector, Charles, A. (2006). FACTORS Affecting Student Achievement in Cost Accounting. *Academy of Educational Leadership Journal; Arden Vol. 10, Iss. 1, (2006): 91-104.*

Kowaliw. (2017). "Homogeneous and Heterogeneous Gender Pairs, Controlling Behavior, And Achievement on a Cooperative Learning Task. *International Journal of Teaching and Learning in Higher Education*.

Lai, E. R. (2011). Critical Thinking: A Literature Review Research Report. *Open Journal of Modern Neurosurgery Vol.6 No.1*, 3-5.

Lowyck, J., Poysa, J. (2001). Design of collaborative learning environments. *Computers in Human Behavior*.

MacGregor, J. (1990). What Difference Does Learning Communities Make? . *Washington Center News*.

MacGregor, J., Anne, G., Mahr, M., Tinto, V, Barbara, L.S. (1992). What Difference Does Learning Communities Make? . *Washington Center News*.

MacPherson, S.E, Crompton, C., Wolters, M. (2015). Collaborative Learning in Healthy Ageing with Familiar and Unfamiliar Partners. *Conference: British Neuropsychological SocietyAt: London, UK*.

Madrazo, G. M. (2005). Brain Research:Implication to Diverse Learners educator. *Undergraduates Asian Social Sciences*, 72.

Manochehr, N. (2006). The Influence of Learning Styles on Learners in E-Learning Environments: An Empirical Study. *journal of Psychology*.

Mei, and Zhan. (2012). Perceptions and Effects on Students' Learning Achievement and Satisfaction Across Environments. *International Society of the Learning Sciences, Inc.; Springer Science + Business Media,*.

Mills, C. M. (2009). Critical Race Theory: A reply to Mike Cole. *SAGE Journal*, 3-4.

Ministry of Education, (2017). Colleges Of Education Teachers Training, *Accra*.

Ministry of Education, (2018). Training For Tutors in Ghana For Quality Education. *Accra*.

Mugny and Doise. (1984). Socio-cognitive conflict and the role of student interaction in learning. *New Review of Social Psychology*.

Newman, E. (2013). The Upgrading of Teacher Training Institutions to Colleges of Education: Issues and Prospects. *african Journal of Teacher Education*.

Nketia, A. (2016). The Influence of Open Strategizing on Organizational Members' Commitment to Strategy. *ResearchGATE*, 5.

Nlemadim, A. (2016). An Evaluation of Preterm Deliveries in a Developing Country. *International Journal of Current Research*, 10.

Oakley, B., Felder, R.M., Brent,R., Elhajj, I. (2004). Turning student groups into effective teams. *10 / Journal of Student Centered Learning*, Vol 2.

ODA/GES. (1993:1). Instructional Practices in the Teacher Training Colleges. *Accra, Ghana*.

Peterson, Janick, and Swing. (1981). The Relationshipof Students Ability and Small Group. Interaction Students Achievements. *American Educational Research Journal*.

Piaget, J. (1969). Piaget's conservation tasks: The logical and development priority of identity conservation. *Journal of Experimental Child Psychology*.

Powell, L. , Kalina, C.J. (2013). Collaborative learning in Action. *Proceedings of 2013 IEEE International Conference on Teaching, Assessment and Learning for Engineering (TALE)*.

Rgskind,C.,Chummabathni (1998). Quantitative approach to collaborative learning:Performance prediction, individual and group composition. Internal . *Journal of Computer supported Learning.*, 5.

Richard, M. Gerard, P.D., Stafford, J., Reinecke,J.K. (2006). Multi-stage sampling for large scale natural resources surveys: A case study of rice and waterfowl. *Journal of Environmental Management*.

Ridge, N. (2009). Teacher Quality, Gender and Nationality in the United Arab Emirates:A Crisis for Boys. *Dubai School of Government*.

Rogooff, R, Tudge, J.R. (1999). Peer Influence and Cognitive Development, Piget and Vygosky Perspective. *Published By: Wiley https://doi.org/10.2307/1131562*.

Romer, K., Whipple, W. (1990). Students' Perception of Collaborative Learning, Conflict Management and Satisfaction in a Private Educational Institution Learning Environment: An Asian: Case Study . *Journal of Education & Social Polic* .

Roschelle, J. & Teaseley, S.D. (1991). the construction of Shared Knowledge in Collaborative Problem Solving. *INC O' Malley(Ed), Computer Supported Collaborative Learning. Berlin, Germany:Springer*.

Rubén, M., Matias, R., Miguel. (2009). Collaborative robotic instruction: A graph teaching experience. *Computers & Education studies*.

Shamusudin, G., Parr, J. (2018). Evaluating Collaborative Management within the National Parks and Building Sanctuaries in Bandgladesh. *The International Journal of Protected Conservation* , Vol 24.1.

Sheard, M. (2009). Hardiness Commitment, Gender, and Age Differentiate University Academic Performance. Educational Psychology, 79, 189-204. *Psychology, Vol.10 No.4,*.

Shen, J., Hiltz, R.S, Bieber, M. (2008). Learning Strategies in Online Collaborative Examinations. *New Jersey Institute of Technology*.

Stahl, T. S., Steven, M. A. (2015). Gender Differences in Physical Activity Patterns Among Older Adults who fall. *ScienceDirect*.

Stasz, C., Eide, E.R, Martowell, P. (2008). Post secondary Education in Employer Demand. *Santa Monica Rand Corporation*.

Stefan, M., Claudia, B, Mihaela, P., (2013). Impact Study Regarding Constructivist Curriculum's Management of Teacher Training. *Procedia - Social and Behavioral Sciences*.

Swan. K., Garrison, D., Richardson, J (2006). A constructivists Approach to online Learning: The Communityof Enquiry Framework, Information Technology and constructivism in Higher Education. *Progressive Learning Framewors*, PA:IGI Global (43-57).

Tsamenyi, M. O.-K. (2010). Knowledge andskills Development of Accounting Graduates:The Perceptions of Graduates and Employers in Ghana. *Jindal Journal of Business Research*, 22.

Tsay, M., Brady, M. (2012). A Case Study of coperative Learning and Communication Pedagogy: Does working in Teams make a Difference? *Journal of the Scholarship of Teaching and Learning*, 79.

T-TEL. (2016). Teaching in Ghana: turning the barrier into the solution. *Ministry of Education,Accra*, 2.

Underwood, J. & Underwood, G. (2014). Task effects on co-operative and collaborative learning with computers. *Open Journal of Social Sciences*.

Vygosky. (1999). Peer influences on cognitive development: Piagetian and Vygotskian perspectives.

Wagner, N. L., Hassan, K., Head, M.M. (2008). Who is Responding for E - Learning Success in Higher Education? . *Analysis Educational Technology and Society*, 30.

Wallace, J. (1993). Do Students who Prefer to learn Alone Achieve Better Than Students who Preferv to Learn with Peers? *Psychology*.

Warger, T. and Dobbin, G. (2009). Learning Environments: Where Space, Technology, and Culture Converge. *Education Learning Initiative (ELI)*.

Waring, M., Carol, Evans, C. (2014). Understanding Pedagogy Developing a critical approach to teaching and learning. *Available on Taylor & Francis eBooks*, 274.

Webb, N. (1991). Problem Solving Strategies and Group Process in Small Groups Learning and Computer Programming. *American Research Journal*, 22.

Weber, A. S. (2010). Web Based Learning. *Centre for International and Regional Studies*.

Yang, K., Woomer, G.R., Judith, T.M. (2012). Collaborative learning among undergraduate students in community health nursin. *Nurse Education in Practice*.

Zahn, C., Karsten, K, Frederick, W., Hesse, Roy, P. (2011). How to improve collaborative learning with video tools. *International Society of the Learning Sciences, Inc*.

Zeid, A., Elbahey, R. (2011). Impact of Introducing Single-Gender Classrooms in. *41st ASEE/IEEE Frontiers in Education Conference*, 5.

Zhan, Mei., Patrick. (2013). Effects of gender grouping on students' group performance, individual achievements and attitudes in computer-supported collaborative learning. *ScienceDirect*, 5.

Zhu, C. (2012). Students' Satisfaction, Performance andKnowledge Construction in Online Collaborative Learning. *Technology and Society*.

Zurita, G. (2005). Introducing a Collaborative Tool Supporting a Learning Activity Involving Creativity with Rotation of Group Members. *Business Universidad de Chile*.

# APPENDIX A: Letter of Consent

UNIVERSITY OF EDUCATION, WINNEBA

FACULTY OF SCIENCE EDUCATION

DEPARTMENT OF MATHEMATICS EDUCATION

Dear Participant,

You are invited to participate in a research study on effect of collaborative learning on students' gender and their mathematics achievement. In particular, I am interested in how students' gender will determine their mathematics performance at the colleges of education in Ghana. This research will require 45 minutes of your time. During this time, you will complete a structured question about your experiences with collaborative learning and gender. Your participation in this research is completely voluntary. However, you may withdraw from the study at any time for any reason. If you do this, all information from you will be deleted. The results from this study will be published in journals read by counselors and academia in mathematics, to help them better understands the experience of effect of collaborative learning on gender in students' mathematics achievements. I have read the above information regarding this research study on the effects of collaborative learning on gender and students' mathematics achievements, and consent to participate in this study.

Date.....

RESEARCHER

Collins Fordjour Nkrumah

# APPENDIX B: QUESTIONNAIRE

1. Do you prefer to perform tasks given to you by the course instructor by yourself?
    A. Yes
    B. No
    C. Sometimes
    D. Most at times
2. Do you prefer to perform tasks given to you by the course instructor with your colleagues?
    A. Yes
    B. No
    C. Sometimes
    D. Not all the times
3. How do you feel when working in a class?
    A. I feel anxiety when working in a class
    B. I do not quickly adapt to the members in the team
    C. I feel comfortable and quickly adapt to the members of the team
    D. I'm thinking all the time about the score that I will get for the task
4. How would you describe your abilities as a team member?
    A. I'm an effective team member because I discuss, share ideas with others and accept other members' opinions.
    B. I'm an effective team member by giving suggestions and supporting my ideas and suggestion with important points that will make our achievements better.

C. I'm an effective team member through continuing active collaboration with each member in the team.

D. I'm sometimes ineffective because some guys will intimidate you when you go wrong

5. What tasks or projects need teamwork to accomplish?

A. The Assignment tasks require teamwork.

B. The project works

C. Group discussions

D. Getting to exams time.

6. What are the tasks or duties that do not require teamwork and can be achieved alone?

A. Quizzes

B. Mid- semester Exams

C. Exercises

D. End of semester exams

7. What are the challenges of collaborative learning?

A. The teamwork are class opinions

B. The variation in the class's opinions

C. Making great efforts to achieve a good job.

D. Effective participation in teamwork and discussing and sharing information.

8. Through this experience, what was your role within your class?

A. Researcher, searching for references on specific topics

B. Divider, sharing out roles to each member in the team

C. Leader, coordinating the team

D. Acting as the group secretary

9. Do you think that teamwork disrupts or impairs task completion in the mathematics class?

   A. Impairs tasks completion due to frequent controversy, which is a difficulty in class working.

   B. Impairs tasks completion, because of lack of time commitment in class working.

   C. Yes, there is sometimes no collaboration with each other in the teamwork.

   D. Impairs task completion due to lack of cooperation in teamwork

10. Which gender class do you prefer to work within the mathematics class?

   A. All males only

   B. All females only

   C. Mixture of the two groups

   D. Working alone

# APPENDIX C: PRETEST

1. On solving 2p - 3q - 4r + 6r - 2q + p, the answer will be

   A. 8q -5r

   B. 10p + 3q - 5r

   C. 3p - 5q + 2r

   D. 7p + 5r

2. The answer of factorization of the expression 4z (3a + 2b - 4c) + (3a + 2b - 4c) is

   A. (4z + 1) (3a + 2b -4c)

   B. (4z + 1) + (3a + 2b -4c)

   C. (4z + 1) - (3a + 2b -4c)

   D. (4z - 1) (3a - 2b -4c)

3. By factorizing the expression 2bx + 4by - 3ax -6ay, the answer must be

   A. (2b + 3a) (x - 2y)

   B. (2b - 3a) (x + 2y)

   C. (2a- 3b) (3x - 2y)

   D. (2a + 3b) (2x - 4y)

4. If -4x + 5y is subtracted from 3x + 2y then the answer will be

   A. 3x + 6y

   B. 2x + 5y

   C. x - 3y

   D. x + 3y

5. On solving the algebraic expression -38b⁄2, the answer will be

   A. −19b

   B. 19b

C. 56b

D. −56b

6. The answer of factorization of the expression (3x - 2y) (a + b) + (4x - 3y) (a + b) is

A. (5x + 5y) (a + b)

B. (5x + 5y) - (a + b)

C. (6x - 8y) + (a - b)

D. (7x - 5y) (a + b)

7. If Ana is x years old then 5 times Ana's age three years ago is

A. 3(x - 5)

B. 5(x - 3)

C. 3(x + 5)

D. 5(x + 3)

8. On evaluating the algebraic expression -3(4s - 2t) - 4(2s + 3t), the answer will be

A. −20s - 6t

B. −6s + 20t

C. 21s - 7t

D. 23s + 8t

9. The sum of 5x + 3y and 4x - 2y is

A. 5x - 8y

B. 9x + y

C. 8x + 4y

D. 6x + 5y

10. If the algebraic expression is [4(a + 2b - 3c) - 3(2b - 3c)] + 2a then the answer will be

    A. 7a - 3b +4c

    B. 6a + 2b - 3c

    C. 8a + 3b - 4c

    D. 9a + 2b + 5c

11. If a = 3, b = 2, c = 4 and x = 5 then (2ab + 3ac) + (3ax - 4acx)/(2abcx - 2x) + 3 is

    A. -2

    B. -10

    C. -5

    D. -9

12. By solving the algebraic expression 2(3m -4n +5) -3(2m -3n +4), the answer should be

    A. m + 2

    B. n - 2

    C. 3m + n - 3

    D. n + 2

13. On evaluating the expression 10(x - 20y) + 100x, the answer will be

    A. 100x + 240y

    B. 110x + 200y

    C. 200x - 110y

    D. 110x - 200y

14. On solving the a⁄4 + a⁄6, the answer will be

    A. 8a⁄5

    B. 7a⁄11

    C. 5a⁄12

    D. 3a⁄10

15. The algebraic expression of the word expression "2 times the number and increased by 3" is

    A. 6a

    B. 2a + 3

    C. 3a + 2

    D. 5a

16. On solving the expression 8c + 4d - c + 3d, the answer will be

    A. 64bcd

    B. 20c -d

    C. 14cd

    D. 7c + 7d

17. The algebraic expression of the price of z kgs of rice at GHC15 per kg is

    A. 15+z

    B. 15z

    C. 15⁄z

    D. z⁄15

18. On simplifying the algebraic expression -13a x -2, the answer will be

    A. −26

    B. 26a

    C. 15a

D. -15a

19. On solving the algebraic expression 2(x - 2y) +4(2y + 3z) -3(x + 4y - 5z), the answer will be

A. -x - 8y - 27z

B. -x - 8y + 27z

C. x + 8y - 27z

D. x - 8y - 27z

20. If the algebraic expression is 2(x - y) + 3(4x -5y) then the answer will be

A. 14x - 17y

B. 17x - 14y

C. 12x - 18y

D. 18x + 30y

# APPENDIX D: POSTTEST

**1.** The set of all real numbers under the usual multiplication operation is not a group since

A. Multiplication is not a binary operation

B. Multiplication is not associative

C. Identity element does not exist

D. Zero has no inverse

**2.** Image 113. If * is defined on R* as a * b = —ab/ 2, then identity element in the group (R*., *) is

A. 1

B. 2

C. ½

D. 1/3

3. The inverse of - i in the multiplicative group, {1, - 1, i , - i} is

A. 1

B. -1

C. i

D. -i

4. On solving 2p - 3q - 4r + 6r - 2q + p, the answer will be

A. 8q -5r

B. 10p + 3q - 5r

C. 3p - 5q + 2r

D. 7p + 5r

5. The answer of factorization of the expression 4z (3a + 2b - 4c) + (3a + 2b - 4c) is

A. (4z + 1) (3a + 2b -4c)

B. (4z + 1) + (3a + 2b -4c)

C. (4z + 1) - (3a + 2b -4c)

D. (4z - 1) (3a - 2b -4c)

6. By factorizing the expression 2bx + 4by - 3ax -6ay, the answer must be

A. (2b + 3a) (x - 2y)

B. (2b - 3a) (x + 2y)

C. (2a- 3b) (3x - 2y)

D. (2a + 3b) (2x - 4y)

7. If -4x + 5y is subtracted from 3x + 2y then the answer will be

A. 3x + 6y

B. 2x + 5y

C. x - 3y

D. x + 3y

8. On solving the algebraic expression -38b⁄2, the answer will be

A. −19b

B. 19b

C. 56b

D. −56b

9. If A = {3, 6, 9, 12} and B = {6, 8, 9} then intersection of A and B is

A. {3, 6}

B. {3, 12}

C. {6, 9}

D. {9, 12}

10. Individual Objects in a set are called

A. Element

B. Set

C. List

D. None of above

11. A set with no elements is

A. a subset

B. a universal set

C. a null set

D. a superset

12. A group or collection of objects is called

A. element

B. set

C. list

D. group

13. The set of vowels in English alphabet contains elements

A. {a, b, c, d, e, f}

B. {a, e, I, o, u}

C. {p, q, r, s, t}

D. {l, m, n, o, p}

## THEORY QUESTIONS

## ANSWER ALL QUESTIONS FROM THIS PART

1a. Find the domain of the function $f(x) = \frac{x-3}{2x-5}$

1b. Calculate for the inverse of the matrix $A = \begin{bmatrix} -4 & 3 \\ -5 & 2 \end{bmatrix}$

1c. Solve for the value(s)of x such that $\left(9 \div \left(\frac{1}{27}\right)^{1+x}\right)^2 = 3^x$

2a. Given that $Z = 3i - 4$. Find$|\bar{z}|$

2b. Solve the system of equation $2x^2 + 3x - 5 = 0$

using completing of the squares.

3a. If E = {30, 31, 32, …,45} and D = {multiples of 4} then complement of D is

4. Sam bought 2 7/5 kg of flour in one week and 3 4⁄15 kg of flour in second week. The flour Sam bought altogether is?