AKENTEN APPIAH-MENKA UNIVERSITY

OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

SCHOOL OF GRADUATE STUDIES

IMPROVING SENIOR HIGH SCHOOL STUDENTS' LOW PERFORMANCE IN MATHEMATICS USING ONLINE TRAINED COLLABORATIVE LEARNING, A STUDY IN SEKYERE EAST DISTRICT

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APRIL, 2023

DECLARATION

STUDENT'S DECLARATION

I, Owusu John declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

Signature ……

Date ……..……

SUPERVISOR'S DECLARATION

I hereby declare the preparation of this work was supervised in accordance with the guidelines for supervision of thesis as laid down by Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development.

Name of Supervisor: Dr. Joseph Frank Gordon

Signature ……

Date ……..……

DEDICATION

I dedicate this work to my dear wife, Vida Teye. It was through her hard work and timely support that helped me accomplish this work.

ACKNOWLEDGEMENT

I express my sincere gratitude to my supervisor, Dr. Frank Joseph Gordon for guiding me through the process of writing this thesis. I have benefited greatly from his encouragements, insightful comments and suggestions. His constructive criticisms really helped me shape the framework of this thesis. I also thank all the other Mathematics Department lecturers of Akenten Appiah-Menka University of Skills Training and Entrepreneurial Development for their instructions, directions and enormous support during my master's programme. I thank Mr. Sarpong Samuel and Mr. Gayheart Danquah who helped me collaboratively during the online instruction for the experimental group. I cannot adequately express my appreciation and indebtedness to Mr. Samuel Owusu-Afriyie, Mr. Yaw Asamoa Mensah, Ms. Osei Abigail, teachers of Sekyere East district, officialdom as well as students of T. I Ahmadiyya Girls' SHS and all other persons who helped me in a wide variety of ways in writing this project. I am really grateful to you all for your selfless support.

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GLOSSARY/ ABBREVIATIONS

1. **Grand OCL:** Grand Online Collaborative Learning website
2. **OCL:** Online Collaborative Learning.
3. **OTCL:** Online Trained Collaborative Learning.
4. **PSU:** Primary Sampling Unit
5. **SHS:** Senior High School
6. **SSUs:** Secondary Sample Units
7. **Traditional Classroom Instruction:** Face-to-face or in-person instruction
8. **USUs:** Ultimate Sampling Units

ABSTRACT

This study was structured using quantitative method approach with quasi–experimental design to help Sekyere East SHS students improve on their low performance in Mathematics using Online Trained Collaborative Learning (OTCL) theory, coined from "Online Collaborative Learning (OCL) theory" of Harasim (2012). The Cluster Sampling methodology applied in this research; led the researcher to select two independent groups of students of T. I. Ahmadiyya Girls' SHS as the Ultimate Sampling Units (USUs) from the entire students of Sekyere East district SHS population. The entire research covered a period of five (5) months. Questionnaires and test instruments were used to collect data from the Ultimate Sampling Units (USUs). The responses from both students and teachers attested to the existence of the research problem, that, Sekyere East Senior High Schools students' low performance in Mathematics was due to the fact that they spent most of their time on social media entertainment instead of learning Mathematics during school vacations and holidays. The researcher capitalized on the students' high interests in using social media to engage them to learn Mathematics collaboratively. The students' scores in the pre-test and post-test were analyzed using SPSS Independent Samples t-test. The analysis showed that there was a significant improvement in the experimental group's performance after they were introduced to Online Trained Collaborative Learning theory.

CHAPTER 1

INTRODUCTION

1.0 Overview

The researcher introduced the study by discussing the background to the study, the problem statement, purpose of the study, objectives, research hypothesis, significance of the study, delimitation as well as limitations and the organization of the study.

1.1 Background to the study

Integration of ICT tools in the teaching and learning processes has been an essential part in the technological development of every nation of which Ghana is not an exception. Wang et al. (2011) stated that "it is encouraging to see young men and women exchange ideas, feelings, pictures, videos and personal information at an astonishing rate on social media." Unfortunately, many Senior High School students overuse social media for entertainment. As ascribed to Bates (2015), cited in NTC of Ghana and Commonwealth of Learning, (2021), even though some professionals argue that social media has the potential of getting our students informed, it was still perceptible that the students' contemporary usage of the internet raised the inevitable issue of quality. There was an unanswered question on how possible it could be for learners to differentiate between accurate, reliable, authoritative information and inaccurate, biased or unsubstantiated information.

According to Harasim (2017) in her book titled "Learning Theories and Online Technology", it is essential for instructors to use Online Collaborative Learning as a theory to build knowledge. Harasim (2017) further stated that: "the most important advantage of knowledge building as an educational approach is the provision of a straightforward way to address the contemporary emphasis on knowledge creation and innovation". According to Harasim (2012), in Online Collaborative Learning, students are encouraged to collaboratively resolve problems by interacting with each other at every stage of the knowledge creation process instead of just memorizing answers. The study added that the instructor plays a very essential role by facilitating the process through provision of appropriate resources and learning activities to encourage students' learning while serving as a member of the knowledge community under study. Bates (2015) stated that the Online Collaborative Learning theory is grounded in, and integrates cognitive development theories which center around conversational learning, deep learning conditions, academic knowledge advancement and knowledge construction.

Just as Harasim, some researchers including: Jenna et al. (2009) and Engstrom (2017) who believed in online theory have conducted studies on online learning as a pedagogy for betterment of students' low performance. These researchers focused only on tertiary students as their target group and not students of pre-tertiary institutions. Again, researchers who had written about online learning only considered sections of the pedagogy used in this research and not the full pedagogy. For instance, Jenna et al. (2009) addressed similar problem in their study using collaborative learning but not online collaborative learning. Also, Engstrom (2017) addressed similar problem by writing on "Implications of learning theories in relation

to distance learning" but did not consider collaborative learning methodology. Harasim (2017) wrote on "Learning theories and online technologies" but did not focus on the training of the participants. Due to this gap, it was therefore fitting that the researcher focused on students of pre-tertiary students and the use of Online Trained Collaborative Learning (OTCL) as a pedagogy for improving low performance of Senior High School students of Sekyere East district in this study.

1.2 Statement of the problem

It had been the case, as depicted on students' report cards and WASSCE results summary reports compiled by some Senior High Schools in the Sekyere East district, that the students of Sekyere East district Senior High Schools scored low marks in WAEC Mathematics examinations (see Appendix E). Survey and informal interviews conducted by the researcher affirmed that social media applications used by the Sekyere East Senior High School students, had little to do with the learning of Mathematics. They rather had higher interest in using the internet or online applications for only entertainment purposes. Abysmal performance in mathematics was presented on the results of T. I. Ahmadiyya Girls' SHS and Effiduasi Senior High/Technical School in the 2021 WASSCE. In the examination, only one hundred and forty-five (145) out of three hundred and fourteen (314), representing 46.2% of T. I. Ahmadiyya Girls' SHS students had a pass grade from A1 to C6. The remaining 53.8% of them failed. Also, as low as seventy-eight (78) out of two hundred and twenty (220) representing 35.5% of Effiduasi Senior High/Technical School students had a pass grade from A1 – C6. Thus, the remaining 64.5% could not further their education to pursue a degree or diploma course in tertiary institutions (see Appendix E).

Furthermore, Sekyere East district Senior High Schools students' report cards, scrutinized by the researcher, showed that the students' performance in diagnostic quizzes conducted at the beginning of school reopening by some of the district schools, with the purpose of monitoring students' study habit when they were on vacations were always below average. The researcher realized through survey conducted that, students of Sekyere East district Senior High Schools underperformed in Mathematics because they spent more hours on social media during vacations than to revise their notes. In the survey, as many as two hundred and seventy (270) and forty (40) out of four hundred (400) respondents said they spent (5 – 6) and (7 – 8) hours respectively on social media each day (see Table 3).

The identified problem however was not peculiar to only students of Sekyere East district SHS. One researcher described social media as a canker that exposes people, especially the young generation, to events that may attract them and keep them engaged in different media contexts for hours. The researcher further noted that overindulgence in social media usage usually leads to reduced productivity and low academic achievements (Alahmar, 2016). Another researcher also explained, that social media is undoubtedly indispensable. However, the researcher noted that students needed to be taught how to benefit from the media and how to avoid being negatively impacted by its sporadic, superficial, and unrepresentative content (Chen & Xiao, 2022). The researcher deduced from the survey conducted as well as the works of (Alahmar, 2016) and (Chen & Xiao, 2022) that, the low performance of Sekyere East district SHS students in Mathematics might be related to their overindulgence in social media usage during vacations. Based on the above stated problem, the researcher deemed it fitting to

assist in directing the students' high interest in using social media to the learning of mathematics using OTCL theory.

1.3 Purpose of the study

The study was aimed at using an Online Trained Collaborative learning (OTCL) other than traditional classroom learning to improve the low performance of students of Sekyere East district Senior High Schools in Mathematics.

1.4 Objectives

The objectives of the study were to:

1. determine the interest levels of students of Sekyere East Senior High Schools in using online ICT tools in learning Mathematics.
2. determine the availability of online ICT tools to Sekyere East Senior High Schools students for the implementation of Online Trained Collaborative Learning.
3. determine the significant difference in students' performance after engaging them in Online Trained Collaborative Learning as compared to their previous performance in traditional classroom learning.

1.5 Research Hypothesis

Ho: There is no significant difference between the performance of students engaged in Online Trained Collaborative Learning and those engaged in only traditional classroom learning.

1.6 Research Questions

The following questions were explored:

1. What are the interest levels of students of Sekyere East District S.H.S in the use of online ICT tools in the learning of Mathematics?
2. What are the online ICT tools available to students of Sekyere East District Senior High Schools for the implementation of Online Trained Collaborative Learning?

1.7 Significance of the study

This study was designed to help bring out guidelines that when translated into action, would assist Sekyere East Senior High School Mathematics teachers to use Online Collaborative Learning to improve students' low performance in Mathematics. Most importantly, this study pointed out recommendations and theories that when put into action by Ghana Education Service (GES), will help curtail the mass failure in SHS students' performance in Senior High Schools end of semester and WAEC Mathematics examinations.

1.8 Delimitations

The research was delimited to SHS students of Sekyere East district with focus on 80 students of T. I. Ahmadiyya Girls' SHS. The duration for the whole research was five (5) months. There was asynchronous teacher – student online discussions as well as tests. Asynchronous online survey questionnaires were also distributed to both students and teachers for responses.

1.9 Limitations

This research had three limitations. Firstly, it was extremely difficult for the researcher to give timely assistance to students who struggled to familiarize themselves with the Graphical User Interface (GUI) of the Grand OCL discussion board. The researcher realized that if the students had been in a confined traditional classroom, it would have been easier for the instructor to provide all the assistance they needed.

Secondly, it was practically impossible for the researcher to observe and analyse nonverbal responses such as facial expressions of students during online discussions because students were geographically positioned in their own convenient locations.

Lastly, the possibility for students not to think for themselves was high; because they could just replicate the solutions of their colleagues when the solutions were posted on the online discussion board for the instructor to assess.

1.10 Definition of terms

Online Collaborative Learning (OCL): Students are connected, encouraged and supported to work together to create or build knowledge out of their own innovations, discussions and experiences to help them solve societal problems. (Harasim, 2017).

Online Trained Collaborative Learning (OTCL): Students are trained and supported by an instructor to use online devices to join their respective virtual groups irrespective of

their locations. The students are encouraged to share and build new convergent knowledge to solve realistic problems.

Moodle: a course management system aimed at creating dynamic online learning communities. Moodle has been used in more than 16 languages in over 115 countries. Teachers have used Moodle as a strong tool for homework, quizzes, chatting room, and surveys (Lauer, 2009).

Grand OCL: An Online moodle class discussion board customized by the researcher to host some students and instructors of Sekyere East district Senior High Schools (www.grand.moodlecloud.com)

1.11 Organization of the study

The thesis was divided into five chapters. The first chapter introduced the background to the study which also specified the research gap. It stated the statement of the problem, research hypothesis, significance of the study as well as the need to conduct the research. The second chapter discussed the theoretical, empirical as well as the conceptual reviews of the study. The third, presented the research design, sampling techniques, instruments used and treatment remedy. The fourth and fifth chapters also discussed data presentation, data analysis, summary of the study, recommendation for next futuristic research and the conclusion of the study.

CHAPTER 2

LITERATURE REVIEW

2.0 Overview

The goal of the study was to redirect the interest in using social media by SHS students of Sekyere East district to the study of Mathematics during vacations. The study aimed at using an Online Trained Collaborative learning (OTCL) other than traditional classroom learning to improve the low performance in Mathematics of students of Sekyere East district Senior High Schools.

2.1 Theoretical review

According to Harasim (2017), Online collaborative learning or OCL, which is currently known as Collaborativist Learning theory is where students are connected from their respective convenient locations by means of internet connectivity via their phones or laptops, encouraged and supported to work together to create or build knowledge out of their own innovations, discussions and experiences to help them solve problems. Harasim believed OCL provided a framework to guide understanding and practice of education in the Knowledge Age by focusing on knowledge-building processes. Harasim said one important advantage of knowledge building as an educational approach was the provision of straightforward way in addressing the contemporary emphasis on knowledge creation and innovation. Harasim (2012) categorized Online Collaborative Learning theory into four (4) main stages which she termed them as Idea generating stage, Idea organizing stage, Intellectual convergence stage and Final position stage. Harasim believed that if an instructor using OCL as a pedagogy in a lesson

delivery focused on those four stages of the theory, it would be practically easier for the learners to understand all the concepts taught without much difficulty. The flow chart below is the diagramatic representation of Harasim's OCL theory which best explains the relationship between the key players in the theory.

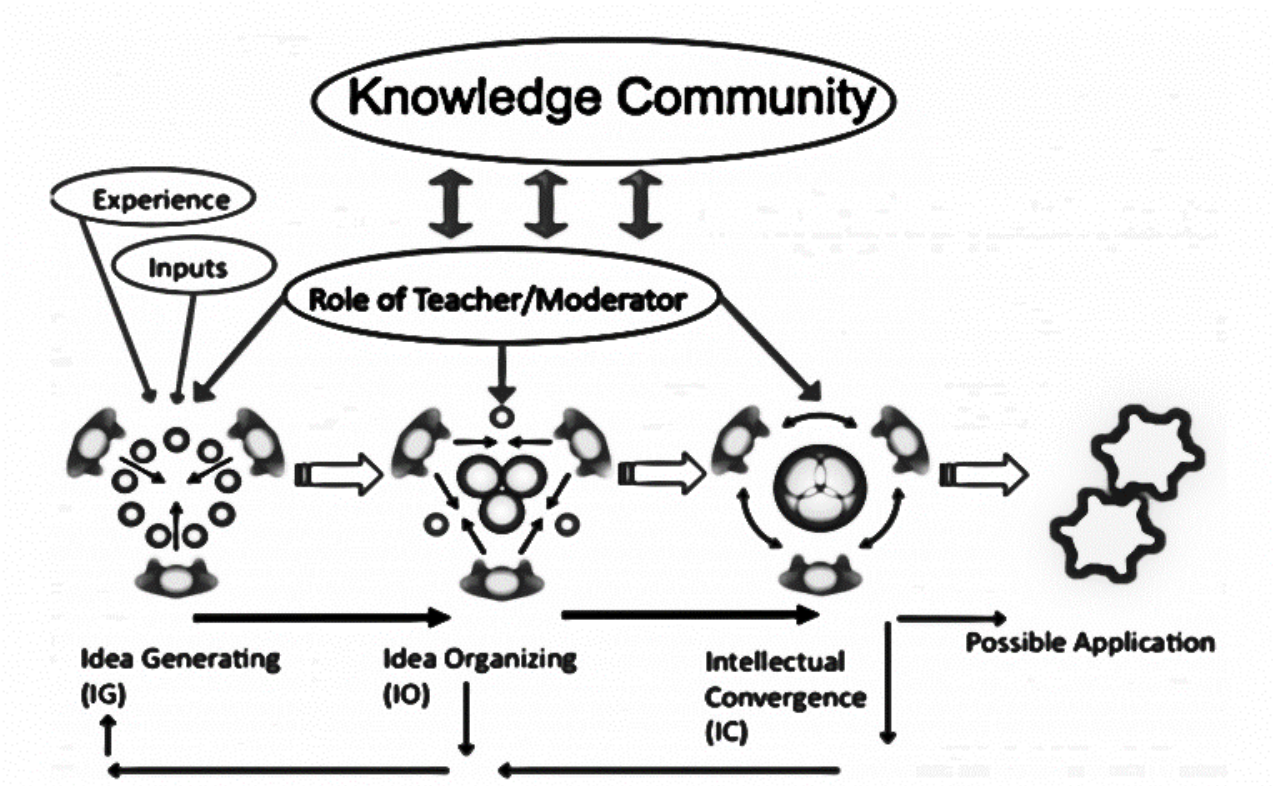

Figure 1: Linda Harasim's OCL theory

2.1.1 Idea Generating stage

According to Harasim (2017), this was the first phase of the application of the OCL theory. At Idea generating stage students were encouraged to engage in divergent thinking within a group; brainstorming, verbalization, generating information, and thus sharing of ideas and positions on a particular topic or problem given by the instructor. As the students generated

ideas, many perspectives emerged. The only role of the instructor was to facilitate idea generation and encourage active participation by all members of the group.

2.1.2 Idea Organizing stage

The phase two was the Idea Organizing stage. Harasim (2017) described it as the beginning of conceptual change. As participants confronted the new or different ideas which had been generated by their peers or encountered in the course readings, they began to discuss in a more focused way to clarify and cluster those many ideas according to their relationship and similarities to one another. Idea organizing behaviour demonstrated intellectual progress and the beginning of convergence, as students discuss and or debate to select the strongest and ousted weaker points by referencing, agreeing, disagreeing or questioning.

2.1.3 Intellectual Convergence stage

Harasim (2017) defined the third phase of OCL as the Intellectual Convergence stage where students typically reflected in shared understanding, shared position or a mutual contribution to and construction of shared knowledge for onward submission to the instructor for grading of their solution to the problem.

2.1.4 Final Position stage

The last stage was the Final Position stage. Here, Harasim (2017) stipulated that the online instructor discussed the possible application of the learners' submitted solutions with them for reuse in subsequent realistic practical problems.

The researcher adopted Harasim's Online Collaborative Learning theory and formulated OTCL theory to help Sekyere East district Senior High Schools students to improve their low performance in Mathematics.

2.2 Empirical review

According to Al-Emran et al. (2019) as cited in Alghizzawi et al. (2019), "The widespread of e-learning by institutional and private providers have provided a new flexible and portable way for students to acquire knowledge sharing skills". The researcher agreed with Al-Emran et al. because it was noticeable that introduction of e-learning in our higher educational sector had helped in alleviating problems that arose with in-person instructions such as insufficient accommodation for the students. The students also have easy access to instructional videos, assignments, tests and also share ideas without the need to spend time and resources to travel to a confined school campus or classroom. Unfortunately, the widespread of e-learning that Al-Emran et al. (2019) cited had not been practiced to the fullest in Sekyere East District Senior High Schools.

According to Selnow (1988), “Every product we buy, every mile we travel, every word we read or hear in the media is touched by a computer.” From what Selnow said, it meant that advancement in technology has created a world in which humans could not exist without integrating computer-based activities in humans’ lifestyle, even in our educational system. The researcher agrees with Selnow (1988) in the sense that, currently, almost every citizen of Ghana including Sekyere East Senior High School students uses computers (Mobile phones, Palmtops, Laptops, etc.) in his or her daily routine.

Selnow (1988) in his paper also pointed out that “Computers have quietly worked their way into our government, business and educational institutions where they now occupy a major, if not, at times, dominant position.” This fact is undisputable. In our contemporary world, it would be very strange for professionals and technocrats to bring forth any meaningful development without the incursion of computers in their grounds of work. Hence, a reason that prompted the researcher to introduce Sekyere East Senior High School students to the effective ways they could use computers with internet such as smart phones and laptops in their studies.

Basook and Higgingbotham-Wheat (1991) stated that, “What makes the computer unique in the long history of educational media is its potential for interactivity.” The researcher affirmed the supposition by Basook and Higgingbotham-Wheat (1991) because it is almost always the case that students and even educated professionals get engrossed in the interactivity aspect of the computer when it is being used for a specific duty. For instance, the writers illustrated that the manner at which video game players get absorbed in the gaming process to the point

where the computer disappears, and the communication between the game environment and the player becomes excessively responsive is one logical reason we can use to explain how computer-based education would be effective during online instructional process. Basook and Higgingbotham-Wheat's statement was one of the reasons that informed the researcher to appreciate the use and introduction of computer-based programmes as unique tools in educational media.

Engstrom (2017) stated in her paper said that: "students that have tendency to hide in the back of a traditional classroom can now develop communication skills." The researcher shared the same credence with Engstrom. Students who are normally shy to voice their opinions in traditional classroom because of being facially identified for providing wrong answers or comments would not fear to share their ideas because they feel their identities are somehow concealed from the rest of the students.

Willis-Flurry and Krentler (2005) stated that "the incorporation of technology in the classroom does enhance actual student learning and that this relationship is moderated by student characteristics." The researcher accepted the assertion of Willis-Flurry and Krentler and even added that if incorporation of technology was not restricted to only the physical classroom, then, it would have enhanced student learning even better.

According to Hew et tal. (2010), the use of internet in schools and homes has resulted in asynchronous online discussion becoming an increasingly common means to facilitate dialogue between instructors and students, as well as *students and students* beyond the

boundaries of their physical classrooms. In that same study, 60% of the students' responses showed that students were motivated to contribute when the facilitator complimented students' contributions. Eighty percent (80%) of the students agreed that the facilitator's responses about their prior contributions motivated them to contribute more, and eighty-six percent (86%) of the students agreed that students were motivated to contribute when the facilitator requested elaboration about their thoughts. Furthermore, eighty-six percent (86%) of the students said that they were motivated to contribute when the facilitator inspired them to contribute, and sixty-six percent (66%) of the students agreed that the students were motivated to contribute when the facilitator summarized what had been discussed. The researcher learnt from the research of Hew et tal. (2010), and motivated the students to ask questions, responded to their questions and inspired them throughout the research period.

Shivcharan (2018) stated in his study that "E-learning has found its special position and identity in today's information age, but its development, promotion and application face different challenges and barriers that require identification, removing and acquiring suitable policies. According to the results, lack of support from e-learning, non-familiarity of the students with English Language, infrastructure problem, students' low knowledge about computer skill and the lack of funding for research and encouragement are part of barrier elements of E-learning." Despite the challenges associated with e-learning that were stated by Shivcharan in his study, the researcher believed that if online instructors and institutional managers were to support and accept online pedagogy as an effective alternative instructional procedure to in-person instruction, students' performance in Mathematics would increase.

Harasim (2012) specified that "online collaborative learning could promote deep learning and encourage discussions at the level of, if not at par, would be higher than discussions found in face-to-face campus classrooms. Harasim believed that the asynchronicity that OCL offered outweighed any downsides, like lack of physical cues." From what Harasim stated, the researcher considered implementation of OTCL on Sekyere East district SHS students as crucial for increasing the students' interest in the study of Mathematics.

Grabe and Grabe (2007), comprehensively stated four roles in online discussion boards. The authors referred to the first role as a technical. According to the authors, an instructor should help students to solve mundane problems that are related to online work. The authors added that it would be important for the instructor to encourage students to join online discussion boards in a non-threatening way. They also termed the second role as social. The social role they said would be related to the responsibility of the instructor to help the students meet each other so they can communicate comfortably. They referred to the third role as managerial and related it to identification of purpose for discussion, definition of roles for students cum instructors, maintenance of fresh discussion boards, establishment of primary expectations for students and response to productive or inert behavior. The authors called the last role pedagogical and related it to the evaluation of the performance of students in discussion as well as directing students' "thinking through" strategies. From the roles of Grabe and Grabe with respect to online discussion, the researcher related their stipulation to that of Harasim (2012) and concluded that; introducing students of Sekyere East district SHS to the online discussion board, Grand OCL, would help in evaluation of the students when they are guided and given feedback via the platform.

According to Spagnoletti et tal. (2015), "… design of the intersection of technology and organizational or social features can result in affordances such as visualizing work processes, real-time or flexible product and service innovation, virtual collaboration, mass collaboration, and simulation or synthetic reality. These affordances, in turn, can result in new ways of organizing online communities." The researcher appreciated the postulation of Spagnoletti et tal. (2015) and introduced "Grand OCL" to Sekyere East district SHS students with the belief of helping them to visualize, collaborate virtually and guide them on the platform to improve their low Mathematical performance through the OTCL approach.

2.3 Conceptual review

Harasim (2017) had a view that "when students are connected, … encouraged and supported to work together they can create or build knowledge out of their own innovations, discussions and experiences to help them solve problems." The researcher adopted Harasim's OCL theory and created another conceptual theory called Online Trained Collaborative Learning (OTCL) theory similar to the OCL.

2.3.1 Online Trained Collaborative Learning Conceptual Theory

Online Trained Collaborative Learning (OTCL) theory is a conceptual theory where students are trained and supported by an instructor to use online devices to join their respective virtual groups irrespective of their locations. The students are encouraged to share and build new convergent knowledge to solve realistic problems. The students construct their own new

knowledge based on their own experiences and discussions under the guidance of an online instructor. The instructor only serves as a guide and an intermediator between the students' convergent knowledge and its application to solve realistic problems. The OTCL theory unlike the OCL of Linda Harasim has only three stages being: Knowledge Development (KD), Knowledge Convergence (KC) and Knowledge Application (KA). Another particularity that makes OTCL unique from other known online theories is the dedication of the online instructor to train the students on the effective use of the online devices and applications. The researcher deemed the training of the students as crucial before the commencement of the actual problem-solving process.

2.3.2 Stages of the OTCL theory

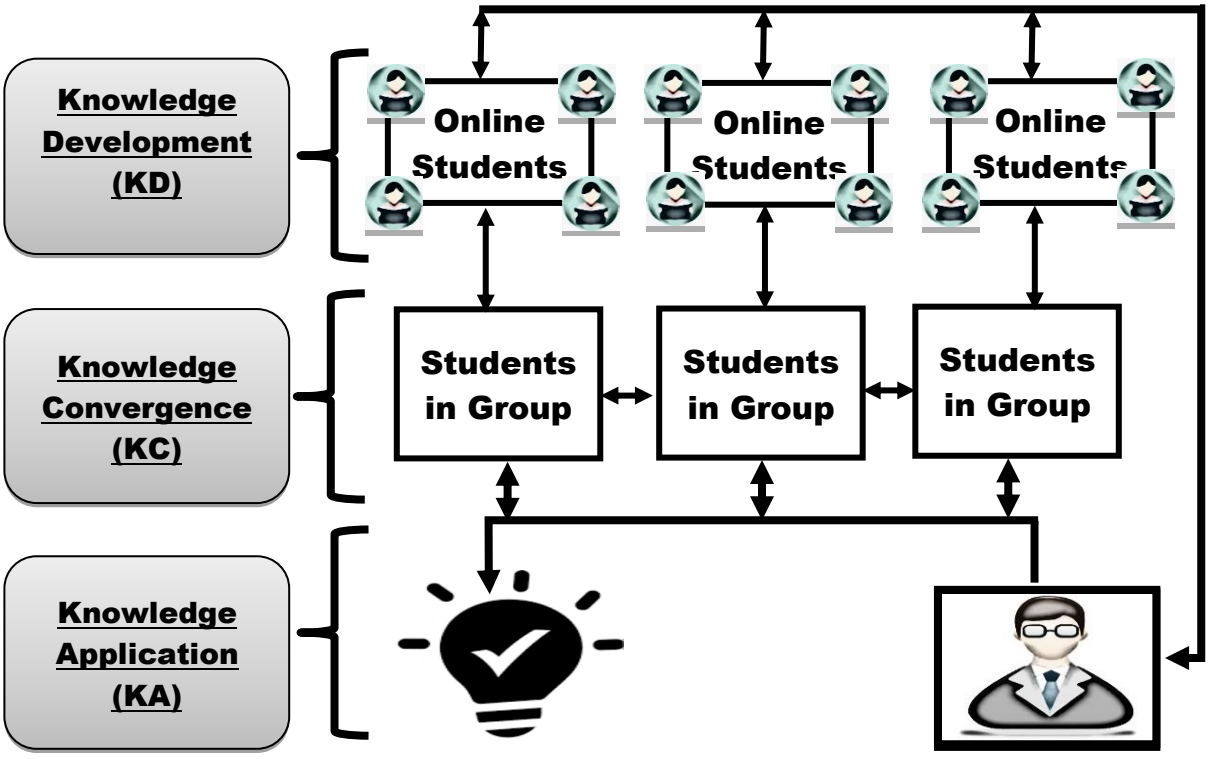

Figure 2: Illustration of the OTCL conceptual theory

Knowledge Development (KD) stage: The researcher positioned Knowledge Development (KD) at the first phase of the knowledge building process of OTCL. At this stage, the researcher measured training of participating students on the effective use of the ICT tools to be a crucial requirement before the commencement of the actual knowledge building process. After the training, each group is tasked and the students encouraged to work individually to develop ideas for solving the problem. The developed points by each student is presented for deliberation, rejection and validation by other members in the assigned virtual group at the Knowledge Convergence stage. The instructor trains and gives guidance to each student and group whenever there is the need to do so.

Knowledge Convergence (KC) stage: The researcher referred to the second phase of OTCL as the Knowledge Convergence where students of the individual groups converge all the points raised by the members, discuss, reject, validate and build on the points to form ideal solution to the given problem. The researcher expects the students to develop positive behavioural qualities such as tolerance and respect for individual's views. The instructor observes keenly and guide each group as they build new ideas. The instructor directs, supports and encourages or retrains any of the groups whenever necessary.

Knowledge Application (KA) stage: This stage was termed as the third and last phase of the OTCL theory by the researcher. At this stage, all the converged ideas to the given problem is presented to the instructor by the individual group leaders for finalization and possible application to solving the identified or future problems.

CHAPTER 3

METHODOLOGY

3.0 Introduction

In this chapter, the researcher discussed the methodology related to the research design, population, population sample, sampling techniques, questionnaires administration, instruments and treatment, tools used in data collection and analysis.

3.1 Research design

The researcher used a quantitative method approach with emphasis on quasi–experimental research design in this study. Quasi–experimental research design is a retrospective study method in which the setting makes it difficult to assign participants randomly to their respective and different groups (Maciejewski, 2020). Quasi-experimental design was more appropriate in this study because the researcher considered different clusters and members for the study as controlled and treatment groups. The participants self-selected their own groups or clusters by indicating their school and course of study. Thus the participants were not randomly assigned to a common group. The main focus of the researcher was to conduct the study in a setting where it would be practically easier to evaluate the effectiveness of the treatment administered. Also, the researcher wanted to manipulate the independent variable (Participating in online trained collaborative learning) whilst observing the effect on the dependent variable (Students high performance in examinations). That comparison enabled the researcher to determine whether there was a significant difference between the performance of the control group and Experimental group.

3.2 Population

The population of the study included all the five final year students and teachers of Sekyere East district Senior High Schools. A total of (7542) students and (58) Mathematics teachers all belonging to Effiduase Senior High/Commercial School, Tijjaniya Senior High School, T. I. Ahmadiyya Girls' Senior High School, Krobea Asante Technical School and Effiduase Senior High/Technical School were considered as the population for the study.

3.3 Sample and Sampling Technique

The researcher used a cluster sampling technique to categorize the Senior High Schools in the district into five clusters. A sample size of (400) students were allowed by the researcher to self-select a cluster, thus, the school they attend. The sample size used was appropriate representative of the population because, when estimating the sample size using a 95% confidence interval and $\alpha = 0.5$, the minimum sample size can be determined by Yamane's formula $n = \frac{N}{(1+N\,d^2)}$, where n = sample size, N = population and d = 0.05 (Adam, 2020). Therefore, with a total population (N) of seven thousand five hundred and forty–two, the minimum sample size (n) was calculated as $n = \frac{7542}{(1+7542\,(0.05)^2)} \approx 380$. However, for efficient representation of the population, the researcher distributed the questionnaires to appreciable sample size of (400) students, All the Fifty-eight (58) Senior High School Mathematics teachers in the district were also selected by the researcher using purposive sampling technique. For manageability of the control and treatment groups, the researcher used simple random sampling technique to select one cluster which was T. I. Ahmadiyya Girls

SHS as Primary Sampling Units (PSU). The researcher later categorized the five programmes (Genneral Science, General Arts, Visual Arts, Business and Home Economics) offered by the school as sub-clusters, referred to as Secondary Sample Units (SSUs). Simple random sampling technique was again used to select two (2) different sub-clusters comprising thirty-eight (38) Business and forty-two (42) General Arts students, totaling (80) students. The (80) students were considered the Ultimate Sampling Units (USUs).

3.4 Instruments

The instruments used to collect data via the Grand OCL website and WhatsApp platforms were teachers' questionnaire, students' questionnaire and tests.

3.4.1 Questionnaires

The researcher designed an online questionnaire at ***https://docs.google.com/forms*** to collect data from both students and teachers. The students and teachers responded to fifteen and five survey question items respectively (see APPENDICES A and B). The student's questionnaire was in two sections. The Section I was made up of nine (9) objective type questions. The Section II which was designed in Likert Scale format had six (6) questions. The teachers' questionnaire on the other hand was made up of five (5) objective type questions. All the questions were designed with clarity so that both teachers and students could answer freely without coercion and concealment of required information. The researcher distributed the online questionnaires to ascertain the interest level of Sekyere East District SHS students in the usage of online tools, either for the study of Mathematics or entertainment.

3.4.2 Tests

There were series of diagnostic tests conducted by the selected school, T. I. Ahmadiyya Girls' SHS, at the beginning of every semester to monitor students' reporting time and study habits during vacations. The researcher analysed the results of the treatment (Business students) and the Control groups (General Arts 2 students) in the latest diagnostic test conducted by the school (see Table I and II below). The pre-test was composed of four (4) standard essay type questions (see APPENDIX C) marked out of 100%. Each question carried twenty-five (25) marks and the students were expected to answer all questions. It was constructed to diagnose the students' level of understanding on the previous concepts taught and to determine if the students had revised their notes enough when they were on holiday break.

After the treatment, the researcher administered essay type questions to the same Control and Experimental groups as post-test, tagged, "Diagnostic Quiz". The post-test was composed of four (4) standard questions (see APPENDIX D) marked out of 100% with each question graded twenty-five (25) marks. The quiz was conducted by the researcher on behalf of the school to check whether the treatment strategy, OTCL employed had a positive effect on the students of the experimental group over the Control group. The scripts were marked and the results were recorded immediately for analysis and comparison. The scores of the experimental and the Control groups were discussed and analysed in detail in chapter four.

3.5 Validity and reliability

According to Ary (2002), “There are two important characteristics that every measuring instrument should possess: validity and reliability”. In this study, the instruments used for data collection were constructed by the researcher to meet the criteria of validity and reliability tests. The questions were designed to measure the performance of the students as expected by the researcher without any compromise. Internal reliability of the measurements was assessed using Cronbach’s alpha (CA) analysis in SPSS (see Tables 1 and 2). Internal reliability is said to be achieved when the alpha score is at least 0.7 (Pomegbe et tal., 2020). It was realized that the test instruments were highly reliable since the Cronbach’s Alpha coefficient was greater ($\alpha = 0.9$).

To ensure validity in the survey questionnaires the researcher used both peer-reviewer and external-reviewer validity testing. The survey items were given to at least six external researchers and the two assistant instructors to evaluate, validate or suggest otherwise for each of the items before they were administered.

3.6 Treatment

The treatment strategy employed by the researcher was mainly based on online practical work. The researcher hosted the thirty-eight (38) Business students on the Grand Online Collaborative Learning website as the experimental group whilst the researcher treated the forty-two (42) General Arts students as the control group with no privilege to participate in the OTCL. The students were grouped and guided to use Grand Online Collaborative website and

WhatsApp group platforms to communicate among themselves during vacation. The ICT tools that the researcher encouraged the students to use for the online lessons included: phones, tablets, palmtops and laptops. Students were put in five-member groups (see figure 5) by the researcher on WhatsApp group platforms. The students were instructed to discuss, solve assignments and exercises in their various groups. They submitted the group's accepted solution on the Grand Online Collaborative Learning (Grand OCL) website for marking. The researcher discussed the marked exercises and assignments with the treatment group on the Grand OCL website for possible application to solve real or advanced problems. The researcher engaged the indulgence of two other instructors during discussion sessions. Students of the treatement group were encouraged to ask questions and comment at every stage of the online treatment process.

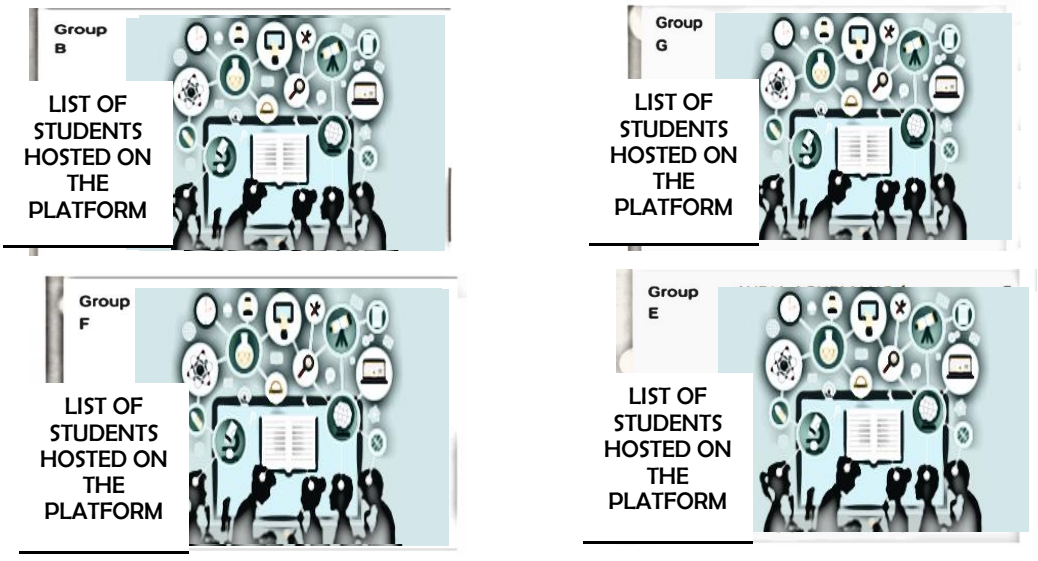

Figure 3: Sample Groupings of the Treatment Group

3.7 Procedures

The researcher designed and hosted the Grand OCL website on the free version of www.moodlecloud.com. The researcher created accounts for each of the participants: the experimental group comprising thirty-eight (38) students, two assistant Mathematics instructors and fifty-eight (58) Mathematics teachers of Sekyere East district Senior High Schools. The home page of the Grand OCL had a list of all the thirty-eight (38) students of the experimental group.

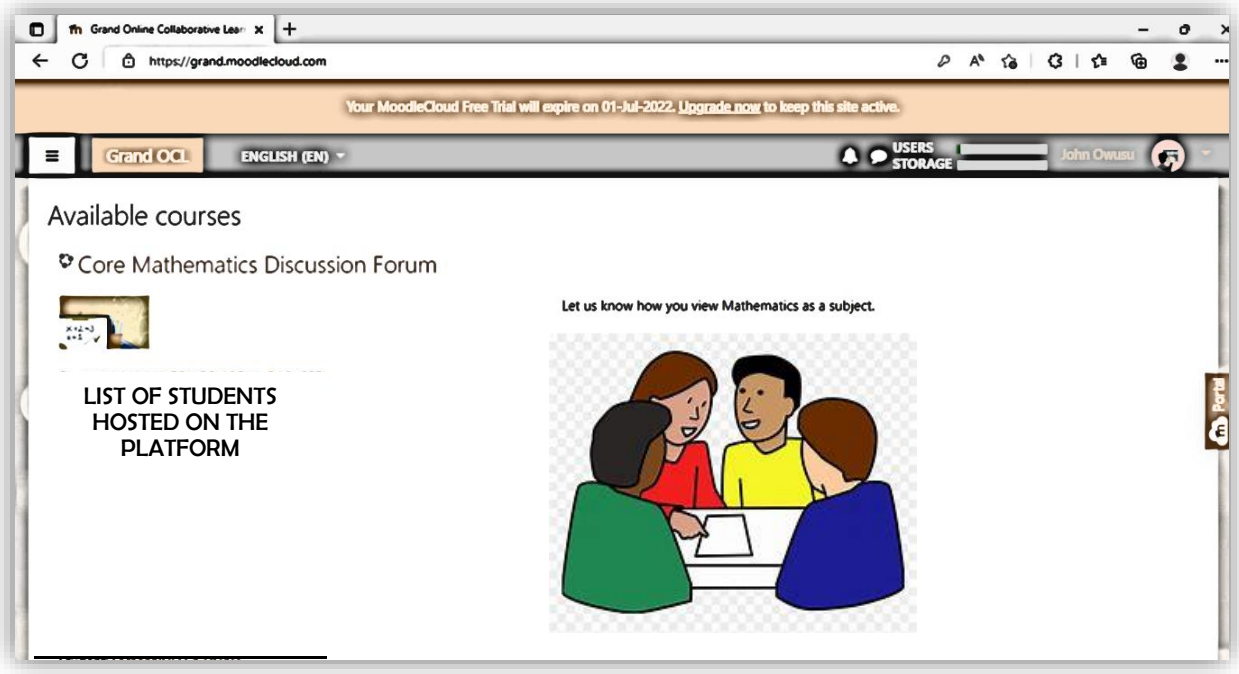

Figure 4: Grand OCL Home page student register

The researcher informed the Heads of Mathematics Departments as well as Mathematics teachers in the district about the intended research for their cooperation. The Sekyere East District Mathematics teachers, the Control group and the students of the experimental group were all allowed to access the google forms survey created by the researcher. The district

Mathematics teachers and Senior High School students in the district were directed to use links:

(*https://docs.google.com/forms/d/11sDcaN88ubFnY_On1rWDwN8Wv6vgbpa2CPecghBg_mE/edit***)** and **(***https://docs.google.com/forms/d/e/1FAIpQLSdpTce0JiaFqE9ZaOK37tH3lEbUqWgD2PKOEg9M21GAWzyNnw/viewform***)** respectively to access the online survey questions. The researcher created two main separate WhatsApp group platforms for both the experimental (38 form 3 business students) and the Control (42 form 3 General Arts 2 students) groups of the USUs. Each of the seven five-member experimental groups were encouraged to select a group leader virtually. The group leaders assisted in creation of their WhatsApp platforms. The Figure 5 below shows the WhatsApp group platforms created and u

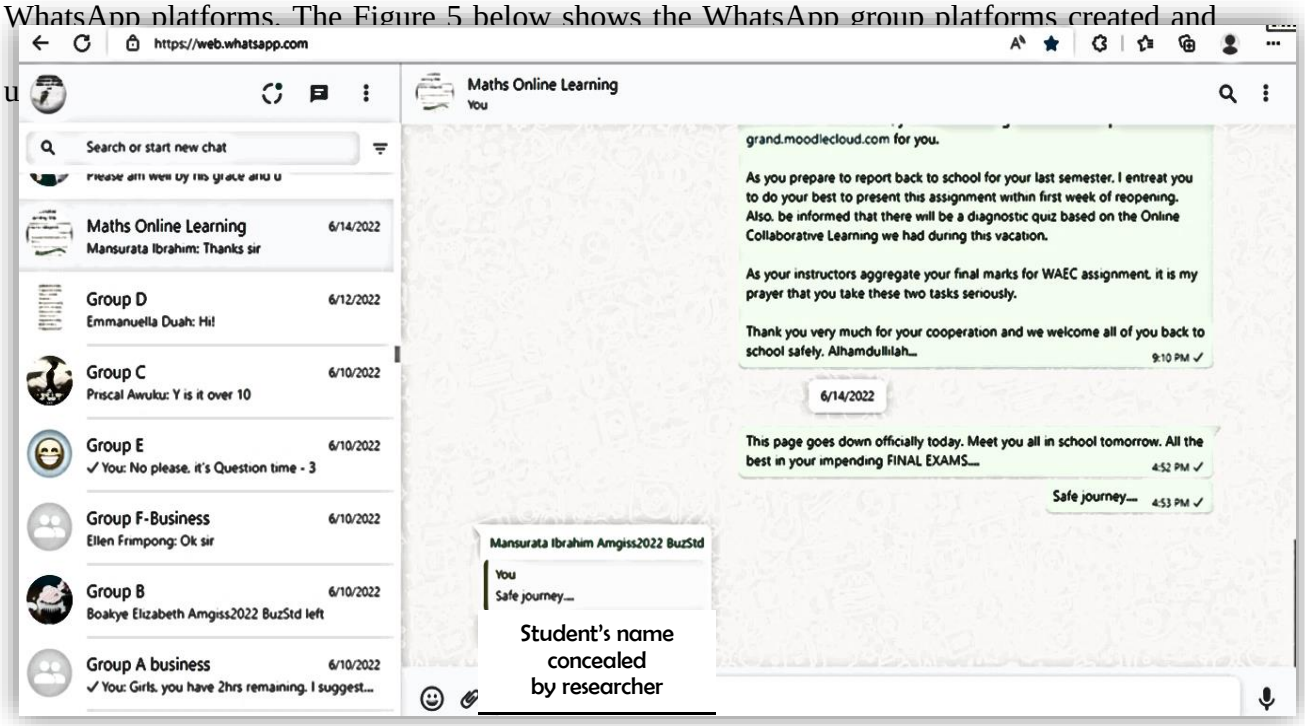

Figure 5: WhatsApp Group platforms for the experimental group

The researcher created login accounts for each of the participants of the experimental group, the two assistant instructors as well as Sekyere East district Mathematics teachers in order to prevent any unauthorized access on the Grand OCL website. (see Figure 6 below).

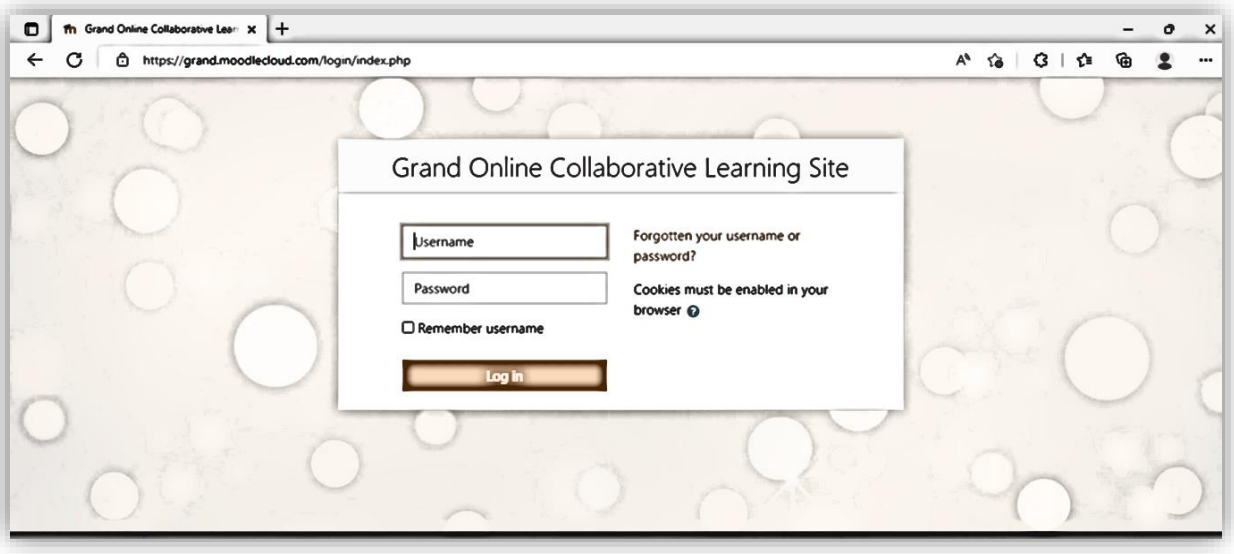

Figure 6: Grand OCL Login page

The experimental group were encouraged to share their beliefs and perceptions on the subject Mathematics. Students were enthused to share their views on how they see Mathematics as a subject. When students were asked to share their thoughts on whether Mathematics was a difficult subject, some of the comments posted by the students were: “No, because it starts with rules and ends with rules”, “It is not. Because it is an everyday thing. Just that we the students do not practice it daily; that is why we complain that it is difficult”. The researcher observed students’ comments; and took notice of each of the comments for onward discussion.

To encourage the students to love the subject Mathematics and to take private and collaborative learning seriously, the researcher gave them questions for them to discuss and solve in their respective groups. The researcher guided the students to discuss the questions using the four main stages in the conceptualized OTCL theory of the researcher. The researcher guided them through knowledge development, knowledge convergent and knowledge application stages of the OTCL. The researcher uploaded the questions on the Grand OCL website for the students to access (see Figure 7 below).

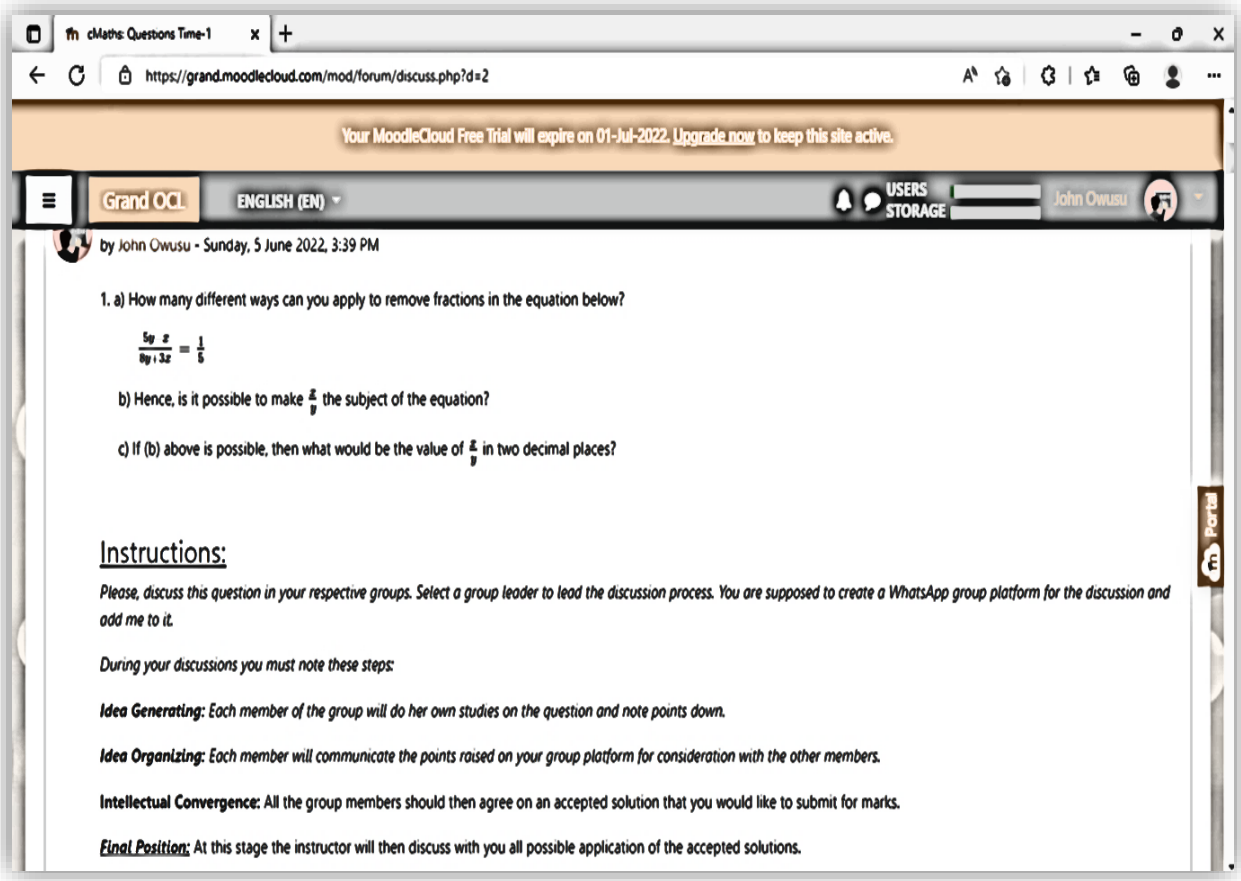

Figure 7: Standard Question Time-1

The students were instructed to solve the questions individually at the Knowledge Development (KD) stage, tolerantly discuss their individual solutions in their respective groups at the Knowledge Convergent stage and present one common solution to the researcher at the Knowledge Application (KA) stage. At the knowledge application stage, the researcher opened the students' minds on possible application of the knowledge they have built to solve more realistic questions. It was observed by the researcher (see Figures 8 and 9 below) that individual students presented their ideas on their respective WhatsApp group platforms for discussions by the entire group members as directed.

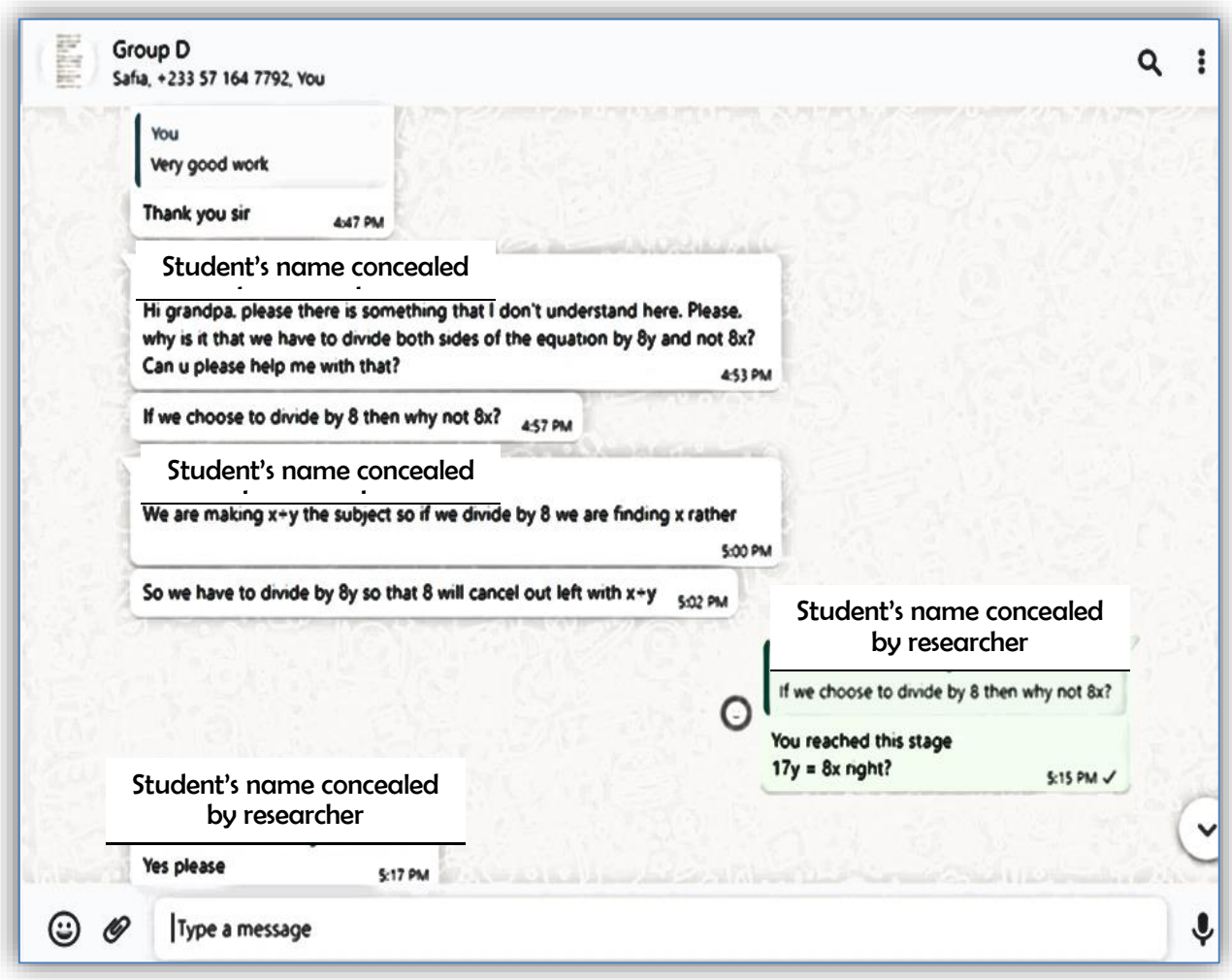

Figure 8: Students in Group D WhatsApp discussion on Question-Time 1

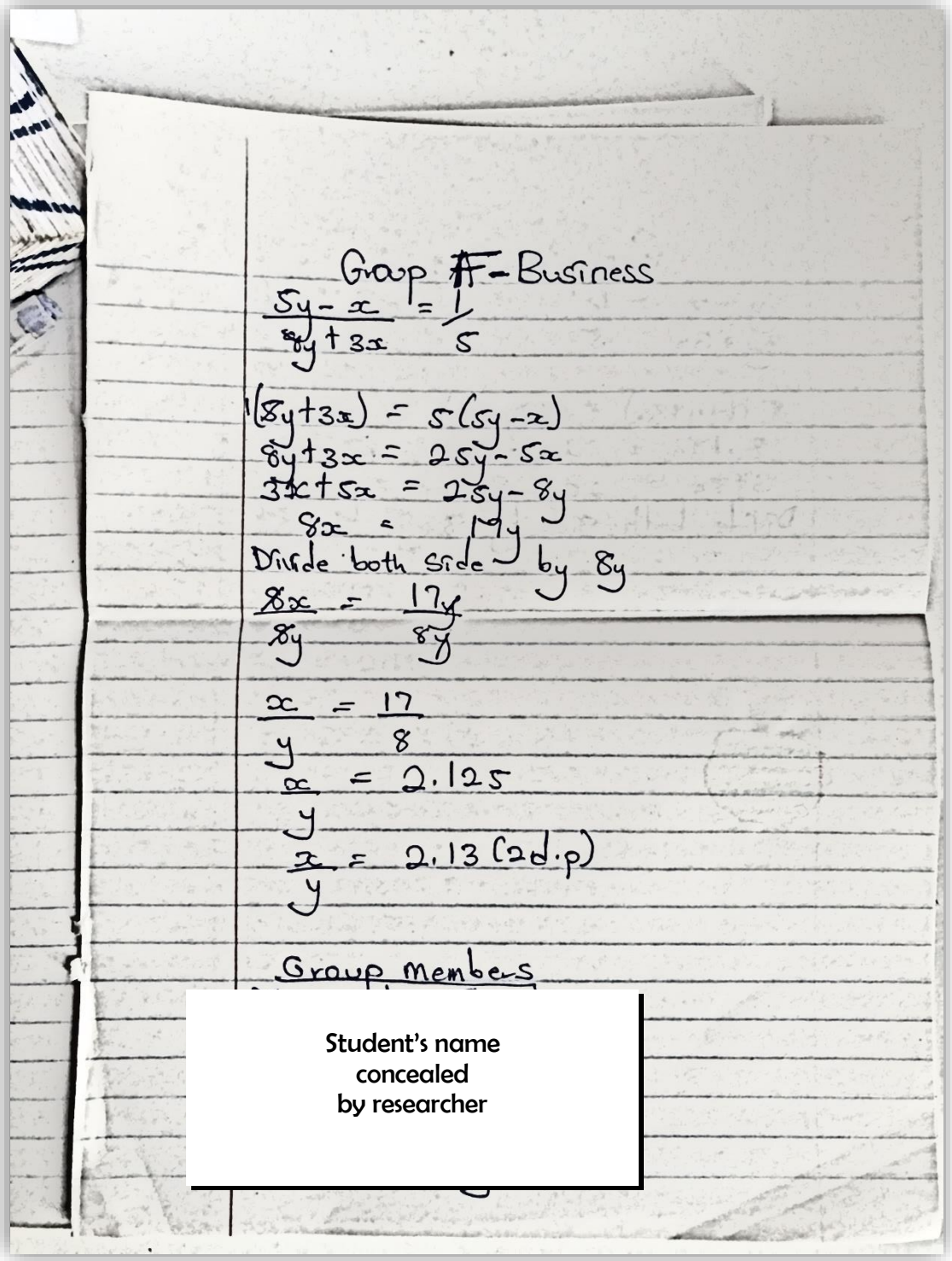

Figure 9: Students Group F resolved Solution to Question Time-1

The researcher uploaded more questions (see Figures: 10 and 11 below) for students to resolve using OTCL theory as described by the researcher. In each case, the researcher and the two assistant instructors were less involved at the knowledge development and knowledge convergent stages of the discussion process.

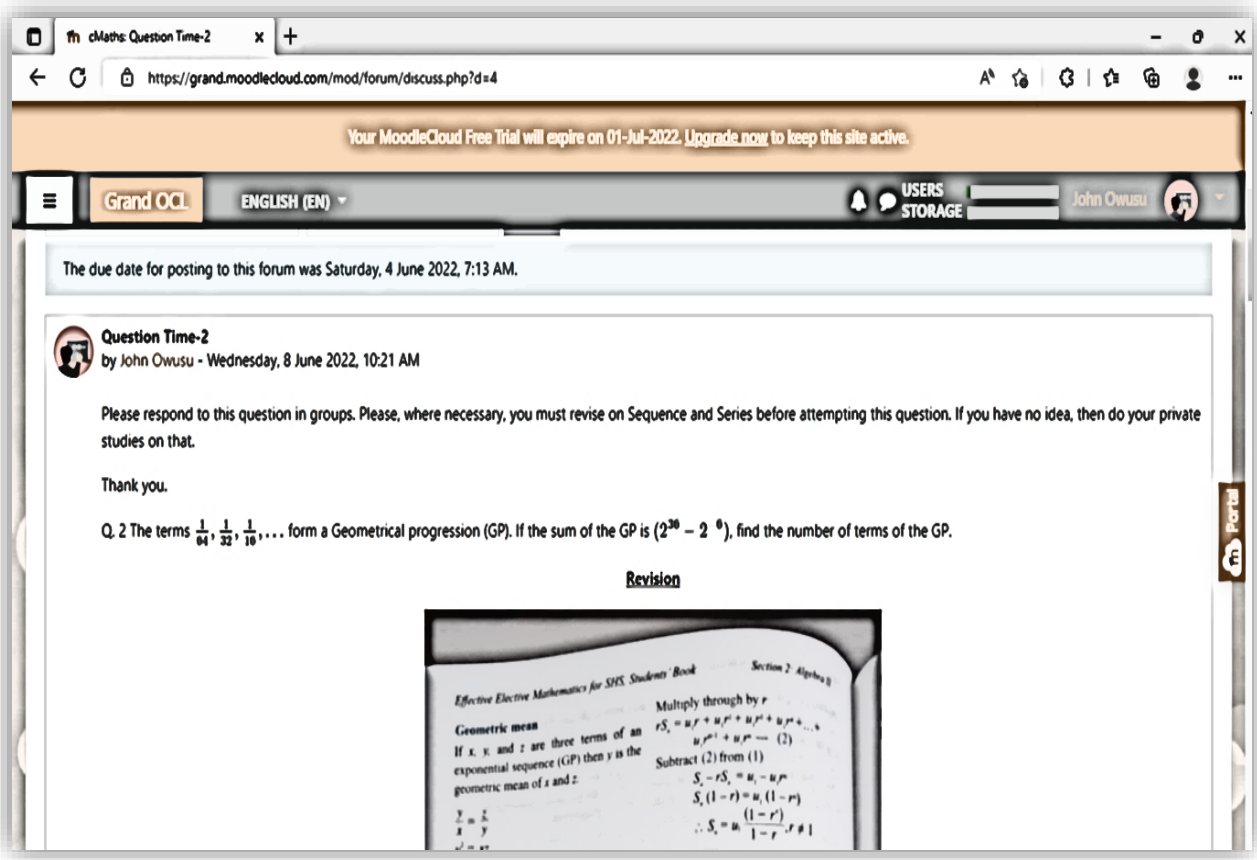

Figure 10: Question Time-2

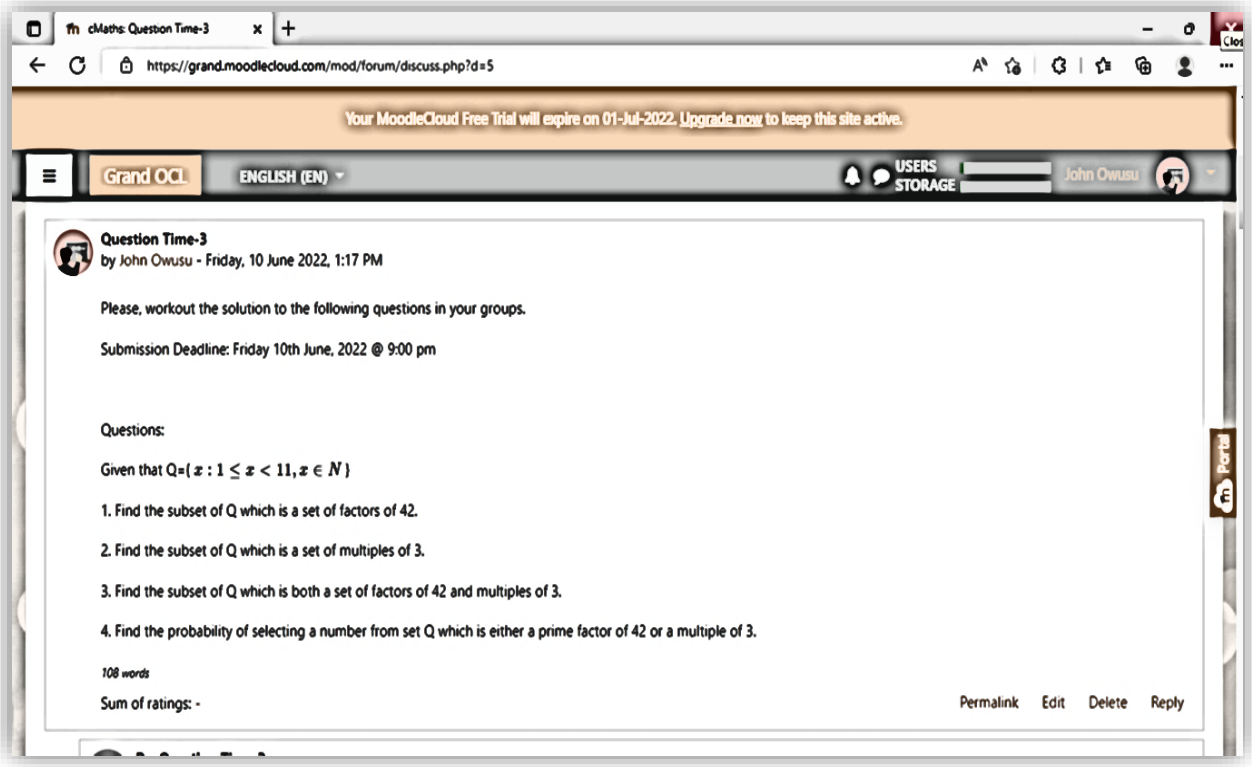

Figure 11: Question Time-3

During the discussion of the tasks given to the students by the researcher, the researcher, only acted as a guide as the students shared their views on the right solutions to the given problems on the Grand OCL website and the WhatsApp platforms. However, the researcher was always available for timely treatments to guide students and groups whenever the needs arose. The researcher also posted correct solutions to the problems on the Grand OCL website after the allocated time for group work submission had expired. This process was repeated severally on different mathematical problems with ascended levels of difficulty. Students asked a lot of questions after the researcher or the other two instructors had posted solutions to the problems on the website. The two assistant instructors and the researcher on several occasions took time to explain to some individual students who still struggled to understand the correct solutions

to the given problems. The researcher contacted groups who had wrong solution approaches to the questions and gave such groups necessary guidance. Most of the students also asked questions on WhatsApp using WhatsApp voice-notes for such questions to be addressed.

3.8 Data collection procedure

The student body and school authorities in the Sekyere East district were informed about the research. The researcher requested for access to students of the USUs' results and analysed the students' performance in Mathematics. The researcher designed survey tool using google forms for a closed-ended survey on eighty (80) students and fifty-eight (58) teachers of the Sekyere East district schools. The district schools were considered by the researcher as the Ultimate Sampling Units. As the Sekyere East district Mathematics teachers were allowed and encouraged to access and respond to the google forms survey for teachers using the website link:***https://docs.google.com/forms/d/11sDcaN88ubFnY_On1rWDwN8Wv6vgbpa2CPecghBg_mE/edit*** the students on the other hand were also allowed and encouraged to access and respond to the google forms survey designed for the students by the researcher on: ***https://docs.google.com/forms/d/e/1FAIpQLSdpTce0JiaFqE9ZaOK37tH3lEbUqWgD2PKOEg9M21GAWzyNnw/viewform.*** Students' marks scored in the individual pre-test and post-test examination were also collected and analysed using SPSS by the researcher to see if there had been performance improvement in the subject.

3.9 Data analysis procedure

The researcher used SPSS to do an independent samples t-test to analyse the test scores of both the experimental and the Control groups. The researcher firstly uploaded the pre-test scores of both groups into for description and comparison. The post-test scores of both the experimental and the Control group were also described and compared using the same Independent Samples t-test.

3.10 Ethical consideration

Before the commencement of the study, the researcher informed teachers and Heads of Mathematics Departments in the Sekyere East district about the research and assured them that the study was only for academic purposes. The researcher also sought formal permission from the Headmistress of T. I. Ahmadiyya Girls' SHS where the USUs were selected from. The researcher informed the eighty (80) students of the USUs about the research and they also agreed to participate fully. The researcher provided a confidentiality statement on the google forms disseminated to both teachers and students. All authors of articles or literature used in this study were credited to the best knowledge of the researcher.

CHAPTER 4

RESULTS AND DISCUSSIONS OF FINDINGS

4.0 Overview

This chapter dealt with presentation of data, analysis and description of scores collected from two different diagnostic quizzes conducted by the school at the beginning of every semester. The researcher tagged two consecutive diagnostic quizzes as pre-test and post-test for this research.

4.1 Data presentation and analysis

The researcher used questionnaires and diagnostic tests conducted before and after the treatment strategy to evaluate the students' performance and interest in participating in the OTCL. A total of (400) students of all the five schools, Effiduasi SHS, Effiduasi SHS/Tech, T. I. Ahmadiyya Girls' SHS, and Tijjaniya SHS, responded to the online questionnaire designed for students. The ultimate sampling units comprising the control group (42 General Arts students) and treatment group (38 Business students) in addition to the questionnaire also responded to tests.

4.1.1 Results on research questions and questionnaires

The researcher used the automatic questionnaire responses generator in google forms to analyse teachers and students' responses to the questionnaires.

4.1.2 Background information of respondents

The researcher used the questionnaire items one to three to ascertain information with respect to the respondent's school background and access to ICT gadgets (see Table 1).

Table 1: Background information of respondents

Student's Questionnaire Item	**Responses**				
	School of Respondent				
	Effiduasi SHS	Effiduasi SHS/Tech.	T. I. Amass Girls' SHS	Krobea Tech.	Tijjaniya SHS
1. Which SHS do you attend in Sekyere East District?	100	75	80	65	80
	Programme of Respondent				
	General Arts	General Science	Visual Arts	Business	Home Economics
2. Which programme do you study in your school?	142	56	72	60	70
	Previous Grade of Respondent before OTCL				
9. What was your grade in Maths for last Semester Exams?	A1 – B2	B3 – C4	C5 – C6	D7 – F9	I Prefer not to say
	6	22	58	296	18

On the questionnaire item 1, eighty (80) representing 20% of the respondents were students of T. I. Ahmadiyya Girls' SHS. The remaining 80% of the respondents were participants from any of the four remaining schools, Effiduasi SHS, Tijjaniya SHS, Krobea Asante Technical and Effiduasi SHS/Tech. schools. On questionnaire item 2, as many as (142) representing 35.5% of the respondents said they were General Arts students and (60) representing 15% were Business students. The remaining 45.5% of the respondents were students of Home Economics, General Science and Visual Art classes. On the questionnaire item 3, though fifteen (18) representing 4.5% said they preferred not to disclose their previous grades, only (6) of them representing 1.5% of them had a previous grade from A1 to B2. Just (22) representing 5.5% had a previous grade from B3 to C4. (58) representing 14.5% had a previous grade from C5 to C6 and as high as (296) representing 74% of them performed below average by obtaining grades from D7 to F9.

4.1.3 Interest levels of students in using online ICT tools in learning Mathematics

The students' responses to the questionnaire items seven and fourteen (see Table 2) on their interest in using online ICT tools to learn Mathematics informed the researcher to know whether the implementation of the OTCL strategy would be feasible.

Table 2: Levels of student's interest in using ICT tools

Student's Questionnaire Item	Strongly Disagree	Disagree	Agree	Strongly Agree
11. I would be interested in partaking online Maths discussions with other students *from* my class.	12	24	140	224
14. I would be interested in partaking online Maths discussions with other students *outside* my class.	0	4	286	110

On the questionnaire item 11, (140) and thirty-three (224) representing 35% and 56% respectively totaling 91% of the students responded they would be interested in online Mathematics discussions with students from their own class. It was only 9% of them who disagreed. Also, on questionnaire item fourteen, (286) and (110) representing 71.5% and 27.5% respectively totaling 99% of the students responded they would be interested in online Mathematics discussions with students from outside their class. Just 1% of the students did not like the idea of having online class with students from outside their class.

4.1.4 Availability of online ICT tools to students for the implementation of OTCL

Students' responses to questionnaire items three and seven informed the researcher about the availability of ICT tools for the implementation of the OTCL strategy. The researcher was aware that in a case where such online ICT tools were not accessible by the students, the implementation of the OTCL strategy would not be practicable.

Table 3: ICT tools availability to students

Student's Questionnaire Item	Responses				
	ICT Gadget used by Respondent				
	Phone	Tablet	Laptop/ Desktop	None of the tools	All of the tools
3. Which ICT gadget do you mostly use to go on internet?	334	36	20	4	6
	Hours spent on social media by respondent				
	0 – 1	1 – 2	3 – 4	5 – 6	7 – 8
5. On the average, how many hours do you usually spend on social-media apps in a day?	8	26	56	270	40
	ICT gadgets usage level by Respondent before OTCL				
	Most often	Often	Sometimes	Hardly	Not at all
7. How often do you use ICT gadget(s) to learn or access Mathematics lessons during vacations?	0	5	65	280	50

On the questionnaire item three, (334) representing 83.5% and (36) representing 9% of the students declared they used phones and tablets respectively to go to the internet. However, on the questionnaire item seven, only (5) representing 1.25% and (65) representing 16.25% of them responded they used ICT gadget(s) "Often" and "Sometimes" respectively to learn Mathematics. No respondent declared they used ICT gadget(s) "Most often". Meanwhile, as

high as (280) representing 70% said they "Hardly" used ICT gadgets to access Mathematics lessons. Also, (50) representing 12.5% declared they had not used ICT gadgets at all.

4.1.5 Test results

Pre-test and post-test scores were recorded by the researcher after marking the scripts of both the experimental (OCL participants) and Control (OCL nonparticipants) groups (see Table 4). The scores were immediately analysed using Independent Samples t – test statistical tool by the researcher.

Table 4: Pre-test and post-test scores for Experimental and Control Groups

Marks (%)	**Pre-test Scores Frequency**		**Post-test Scores Frequency**	
	Experimental Group	Control Group	Experimental Group	Control Group
0 - 10	4	3	0	3
11 - 20	5	6	1	7
21 - 30	6	5	2	6
31 - 40	8	8	3	4
41 - 50	8	11	5	10
51 - 60	5	6	10	7
61 - 70	2	3	8	5
71 - 80	0	0	7	0
81 - 90	0	0	2	0
91 - 100	0	0	0	0
Total =	**38**	**42**	**38**	**42**

The Table 4 above shows both the pre-test and post-test scores for the experimental and control groups. The pre-test was administered before the OTCL strategy, after which the post-test was also administered to both groups. The scores of the pre-test recorded for both the experimental and control groups showed that none of the students could score a mark between seventy (70) and hundred (100). It was realized that only seven (7) out of thirty-eight (38) students of the experimental group scored from 51% to 100% in the pre-test but as many as twenty-seven (27) out of thirty-eight (38) students of the experimental group scored from 51% to 100% in the post-test. Also, the students of the control group performed almost equally the same in both the pre-test and post-test. Only nine (9) and twelve (12) students out of forty-two (42) scored marks from 51% to 100% in both the pre-test and post-test respectively.

The Table 5 below shows descriptive statistics of both pre-test and post-test scores for the experimental group. Comparing the pre-test scores to the post-test scores, it was clear that the students scored higher marks in the post-test than they did in the pre-test (see Table 5).

Table 5: Descriptive Statistics of pre-test and post-test scores for Experimental Group

	Pre-test Scores		Post-test Scores	
	Statistic	Std. Error	Statistic	Std. Error
Mean	33.45		58.55	
Std. Deviation	17.45		16.50	
Minimum	0.00		18.0	

Maximum	63.00		86.0	
Skewness	- 0.37	0.38	-0.61	0.38
Kurtosis	- 0.48	0.75	-0.02	0.75

From the descriptive statistic recorded in the Table 5, the mean score ($\bar{x} = 33.45$) with standard deviation of ($S.D = 17.45$) showed that the pre-test scores of the experimental group were distributed by about (17.40) marks around the mean. Also, the maximum score was ($X_{max} = 63.00$) and the minimum score was ($X_{min} = 0.00$). It was clear that the students of the experimental group underperformed in the pre-test. The post-test mean score of the experimental group was ($\bar{x} = 58.55$) which was more than their previous mean score in the pre-test by a huge difference of about (25.10). Also, the experimental group had a post-test standard deviation of ($S.D = 16.50$) which was lower than that of their own pre-test scores standard deviation by about (0.96). The post-test maximum score was ($X_{max} = 86.00$) and the minimum score was ($X_{min} = 18.00$).

The Table 6 below shows descriptive statistics of both pre-test and post-test scores for the control group. Comparing the pre-test scores to the post-test scores, it was clear that there was no much difference between pre-test and post-test scores for the control group (see Table 6).

Table 6: Descriptive Statistic of pre-test and post-test scores for Control Group

	Pre-test Scores		Post-test Scores	
	Statistic	Std. Error	Statistic	Std. Error
Mean	37.57		37.98	
Std. Deviation	16.95		18.62	
Minimum	6.00		6.00	
Maximum	63.00		68.00	
Skewness	-0.30	0.37	-0.14	0.37
Kurtosis	-1.01	0.72	-1.23	0.72

From the above Table 6, the pre-test mean score of the control group was ($\bar{x} = 37.57$). The table again shows a pre-test standard deviation of ($S.D = 16.95$). Furthermore, the control group's pre-test maximum ($X_{max} = 63.00$) and minimum ($X_{min} = 6.00$) scores were very low. The Table 6 further showed statistically that the post-test mean score of the Control group (OTCL nonparticipants) was ($\bar{x} = 37.98$) which was just about (0.40) lower than that

of their own pre-test mean score. Their standard deviation ($S.D = 18.62$) differed slightly from that of their own pre-test scores standard deviation by about (1.67).

4.2 The significant difference between the performance of students engaged in Online Trained Collaborative Learning and those engaged in only traditional classroom learning.

Comparison was made by the researcher using SPSS Independent Samples T-Test to find out if there was a statistical distinction between the pre-test and post-test scores of the experimental and Control groups. The equal variance assumed obtained from SPSS Independent samples t-tests as displayed in Tables 7 and 8 below helped the researcher to have a better view on whether the competency scores for Experimental and Control groups were similar in shape.

Table 7: Independent samples t-test of pre-test for Experimental and Control Groups

Group	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Experimental Group	38	33.45	17.45	1.07	78	0.29
Control Group	42	37.57	16.95			

From Table 7 above, the mean scores of pre-test for experimental and control groups were (33.45) and (37.57) respectively. Thus, the mean difference was about (4.12). The t-value (1.07) with 78 degrees of freedom had significant level (p-value=0.29) which was far greater than alpha value ($\alpha = 0.05$) to mean that statistically, there was no significant difference between the pre-test scores for the Experimental and Control groups.

Table 8: Independent samples t-test of post-test for Experimental and Control Groups

Group	N	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Experimental Group	38	58.55	16.50	5.21	78	0.00
Control Group	42	37.98	18.62			

From Table 8 above, the mean scores of post-test for experimental and control groups were (58.55) and (37.98) respectively. Thus, the mean difference was about (20.58). Also, the t-value (-5.21) with 78 degrees of freedom had significant level (p-value=0.00) which was far less than alpha value ($\alpha = 0.05$) to indicate that statistically, there was significant difference between the post-test scores for the Experimental and Control groups.

4.3 Discussion of Findings

The researcher discussed the study findings based on the research objectives to draw conclusion. The researcher compared the study findings with the theories and findings of other researchers to find out the harmony or discrepancies among them.

4.3.1 Discussion of findings on interest levels of students in using online ICT tools in learning Mathematics

Hew et tal. (2010), stated in their book that "the use of internet in schools and homes has resulted in asynchronous online discussion becoming an increasingly common means to facilitate dialogue between instructors and students, as well as *students and students*". The

researcher deduced from the quote of Hew et tal (2010) that most students might have interest in using online ICT tools before they availed themselves to be engaged in asynchronous online discussion with their colleagues. Hew et tal (2010) continued to state that 80% of the students agreed to contribute more in an online instruction class as long as the facilitator complimented them.

Also, Wang et al. (2011) stated that "it is encouraging to see young men and women exchange ideas, feelings, pictures, videos and personal information at an astonishing rate on social media." It can be deduced from Wang et al. (2011) statement that contemporary students already have high tendencies to use the internet to express themselves.

The statements of those researchers above were in harmony with the researcher's data presentation in Table 2. From the table, 92.6% of the students declared their interest in using online ICT tools to learn Mathematics. The researcher therefore concluded that the OTCL strategy would be practicable to be implemented since students have high interest in online discussions.

4.3.2 Discussion of findings on availability of online ICT tools to students for the implementation of OTCL strategy

Selnow (1988) in his paper pointed out that "Computers have quietly worked their way into our government, business and educational institutions where they now occupy a major, if not, at times, dominant position." Selnow (1988) finding was not different from the researcher's

results in Table 3. Students' responses to questionnaire item three showed that 98.8% of the students said they had access to online ICT gadgets to go on social media. Just a student responded that she had no access to an online ICT gadget.

From Table 3, the researcher realized online ICT tools were available to the students just that the tools were mostly being used for entertainment purposes. For instance, the students' responses to questionnaire item seven, as high as thirty (30) representing 37.5% and thirty (30) representing 37.5%, totaling 75% declared that they "Hardly" and they did "Not at all" use ICT gadgets to learn or access Mathematics lessons. With that record, the researcher concluded that the implementation of the OTCL was practicable, only that the students needed to be encouraged and guided to accept it.

CHAPTER 5

SUMMARY, RECOMMENDATIONS AND CONCLUSION

5.0 Overview

This chapter summarizes the research findings, reflections, limitations and gives recommendations and conclusion accordingly for further research.

5.1 Summary

The research was conducted using True Experimental research design to find out whether Online Trained Collaborative Learning theory approach could address Sekyere East district Senior High Schools students' low performance in Mathematics. The main instruments used for data collection were essay type tests and online questionnaires. The entire set of fifty-eight Sekyere East district Mathematics teachers were selected using purposive sampling technique and interviewed. A total of eighty students were also selected from students of Sekyere East district Senior High Schools using cluster sampling technique for the study. Relevant ICT tools, social media applications and online learning website were used during the data collection and treatment processes. The responses to the online survey attested to the existence of the research problem, that, Sekyere East Senior High Schools students' low performance in Mathematics was attributed to the fact that they spent most of their vacation or holiday period for entertainment on social media instead of learning Mathematics. The scores collected from the pre-test and post-test were compared and analyzed statistically using SPSS Independent Samples T-Test. The post-test results revealed that the Online Trained Collaborative Learning

conceptual theory employed, was effective in dealing with the research problem. Hence, there was a significant improvement in the students' low performance after they had been introduced to the treatment strategy.

5.2 Summary of findings/ Major findings

The researcher after analyzing the students' responses

The researcher after analysing the responses to the questionnaires and tests concluded on the following findings:

5.2.1 Interest levels of students in using online ICT tools in learning Mathematics

The researcher found from the survey questions that the Sekyere East SHS students had less interest in using ICT tools to learn mathematics. They rather preferred to use the tools on social media for entertainment. That had contributed to their low performance in the study of Mathematics.

5.2.2 Availability of online ICT tools to students for the implementation of the OTCL

The researcher found from the students' responses to the survey questions that most of them had access to online ICT tools and they agreed to use them for the implementation of the Online Trained Collaborative Learning theory.

5.2.3 Significance difference between performance of students engaged in OTCL and those not engaged in OTCL.

The researcher after analysing the pre-test and post-test scores found that the scores recorded for the treatment group showed a significant improvement in the post-test scores as compared to their pre-test scores whilst the scores recorded for the control group showed no significant difference in both tests. The researcher concluded that the implementation of the OTCL strategy was effectual on the treatment (experimental) group.

5.3 Conclusion

This study just like number of other studies focused on the participation of students on online discussion board. The students were divided into two groups. Experimental or OTCL participants group and Control or nonparticipants group. The pre-test and post-test scores of eighty (80) Senor High School students of Sekyere East district were analyzed using descriptive and independent samples t-test. Prior to that, asynchronous online surveys were carried out using Google forms. Participants group posted their ideas and opinions and replied to other students' comments through social interaction on the "Grand OCL" website. The researcher observed that the participants of the experimental group collaborated and cooperated fully with each other during the online discussion. The researcher also noted that the OTCL strategy applied made the instruction mode to be much more student-centred as compared to in-person class settings. However, the researcher noted it was practically difficult to use mathematical and scientific notations on WhatsApp group platforms.

After the OTCL intervention strategy, the researcher concluded on the researcher's hypothesis by finding independent samples t-test of pre-test and post-test results for both the experimental and control groups. From Table 10, the probability value of (0.00) was less than the alpha value of $(\alpha = 0.05)$. Thus, the researcher's hypothesis, which was "There is no significant difference between the performance of students engaged in Online Trained Collaborative Learning and those engaged in only traditional classroom leaning" was rejected. Thus, Online Trained Collaborative Learning (OTCL) treatment strategy was positively effectual in improving Sekyere East district SHS students' low performance in Mathematics (see Appendix E).

5.4 Recommendations

The researcher recommends that:

- Workshops and refresher courses should be organized regularly by Ghana Education Service for teachers on inculcation of ICT tools in lesson delivery to activate students' interest in studying Mathematics so that students will see the lessons as edutainment and fun.

- Heads of pre-tertiary institutions and educational directors should devise strategies to encourage Mathematics teachers to use online instruction to direct students' attention to the study of Mathematics during school recesses.

- Teachers should organize Mathematics competitions for students at the beginning of every semester for students and prizes awarded to praiseworthy students to boost their interest in learning Mathematics during vacations.

- Ghana Education Service should encourage online educational website developers to make their websites' user interface convenient and mathematically friendly enough for students and Mathematics teachers.

5.5 Suggestions for further studies

The researcher noted some useful insights for next research. The researcher suggested that:

Permissions should be sought early enough from the schools through district, municipal or regional education offices for full compliance of the students and school officials.

For continuous flow of planned online activities, any researcher who attempts this same study should do well to fully train the experimental group on the use of online ICT tools before the commencement of the online collaborative instruction.

Mathematics teachers should be encouraged by school heads to make use of computer laboratories during in-person instructions to enable students who do not have access to computers in their houses get familiarized to computer basics before online mathematics instructions intervention is organized on vacations.

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APPENDIX A

QUESTIONNAIRE FOR STUDENTS

AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

DEPARTMENT OF MATHEMATICS

GRADUATE SCHOOL

IMPROVING SENIOR HIGH SCHOOL STUDENTS' PERFORMANCE IN MATHEMATICS USING ONLINE COLLABORATIVE LEARNING, A STUDY IN SEKYERE EAST DISTRICT

Introduction

This questionnaire is designed for Sekyere East SHS students to find out what they think or feel about a kind of learning, where students are connected from their respective convenient locations via phones or laptops by means of internet connectivity. The main aim of this learning theory is to encourage the students to work together; such that they can build their own Mathematical knowledge for the purpose of improving their performance in Mathematics.

Confidentiality statement

Please, you are assured that the information you provide will be treated strictly confidential and will only be used for academic purposes only.

Section I: Please, select the option that corresponds to your answer in the following.

1. Which Senior High School do you attend in Sekyere East District?
    - Effiduase Senior High/Commercial School
    - Effiduasi Senior High/ Technical School
    - T. I. Ahmadiyya Grils' Senior High School
    - Krobea Asante Technical School
    - Tijjaniya Senior High School

2. Which programme do you study in the school?
    - General Arts
    - General Science
    - Visual Arts
    - Business
    - Home Economics
    - Technical course
    - Other: _____

3. Which ICT gadget do you mostly use to go on internet for entertainment purposes?
    - Phone
    - Tablet
    - Laptop/ MacBook/ Desktop
    - Other: _____
    - None: I do not have access to any ICT gadget

4. Which Social media app do you mostly use during vacations or Holiday?

- WhatsApp
- Facebook
- YouTube
- Instagram
- TikTok
- Twitter
- Other: _____
- None: I do not have access to any ICT gadget

5. On the average, how many hours do you usually spend on social media apps in a day?

- 0 – 1 hour
- 2 – 3 hours
- 4 – 5 hours
- 6 – 7 hours
- 8 – 10 hours

6. Do you think it is difficult to use any of the social media apps?

- Yes, it is VERY difficult
- Yes, it is difficult
- It is somehow difficult
- No, it is easy
- I have not used any social media app before

7. How often do you use ICT gadget(s) to learn or access Mathematics lessons during vacations?

- Most often
- Often
- Sometimes
- Hardly
- Not at all

8. Do you think Senior High School General Mathematics is a difficult subject?

- Yes, it is VERY difficult
- Yes, it is difficult
- Somehow difficult
- No, it is easy
- I prefer not to say

9. What was your grade in General Mathematics for last semester examination?

- A1
- B2
- B3
- C4 – C6
- D7 – E8
- F9
- I prefer not to tell

Section II: Please respond to the following statements according to your Mathematical self-efficacy. Select either "Strongly Disagree", "Disagree", "Agree" or "Strongly Agree" for statements 10 - 15.

Table 1. The distribution of respondents according to Mathematical self-efficacy

Item	Strongly disagree	Disagree	Agree	Strongly agree
10. I always forget Mathematical concepts learnt when schools are on vacations or Holiday.				
11. I would be interested in partaking online Mathematics discussions with other students from my class.				-
12. I believe I can understand difficult concepts in mathematics provided I am guided by a teacher online.				
13. I am confident that I can assist my online group to complete assigned tasks given to us during online Mathematics lesson.	-			
14. I would be interested in partaking online Mathematics discussions with other students from my class.				
15. I am confident that my Mathematics performance will improve when I join online Mathematics lessons with my classmates during Holiday or vacations.				

APPENDIX B

QUESTIONNAIRE FOR TEACHERS

AKENTEN APPIAH-MENKA UNIVERSITY OF SKILLS TRAINING AND ENTREPRENEURIAL DEVELOPMENT

DEPARTMENT OF MATHEMATICS

GRADUATE SCHOOL

IMPROVING SENIOR HIGH SCHOOL STUDENTS' PERFORMANCE IN MATHEMATICS USING ONLINE COLLABORATIVE LEARNING, A STUDY IN SEKYERE EAST DISTRICT

Introduction

Dear Teacher,

You have been contacted by a researcher to use approximately three (3) minutes of your time to provide responses to this questionnaire which has been designed based on the research topic: "Improving Senior High School student's performance in Mathematics using Online Collaborative Learning (OCL), a study in Sekyere East District."

Confidential Statement:

Please, be rest assured that the information you provide in this research shall only be used for academic purposes and will not be used to identify you in any way.

Section 1: Please select the options that correspond to your views and beliefs.

1. Among “Any other subject”, “Mathematics” and “Social-media entertainment”, which one do you believe your students do spend more time to discuss with their colleagues during vacations or Holiday?
    - Any other subject
    - Mathematics
    - Social-media entertainment
    - Other: _____

2. As SHS Mathematics teacher in Sekyere East district, what do you think would currently be your students’ Mathematics performance if they were to be examined in the first week that school re-opens, before any traditional (face-to-face) instruction takes place?
    - Excellent
    - Very good
    - Good
    - Average
    - Below average

3. As SHS Mathematics teacher in Sekyere East district, what do you think would be your students’ Mathematics performance if they were to have more discussions in Mathematics with their colleagues on internet platform during vacations or Holiday?
    - Excellent
    - Very good
    - Good
    - Average
    - Below average

Section II: Please select your level of recommendation for your students with respect to Online Collaborative Learning (OCL).

According to Linda Harasim (2017), Online Collaborative Learning (OCL) theorem which is also known as Collaborativist Learning theorem is where students are to be connected from their respective convenient locations by means of internet connectivity via their phones or laptops. They are then to be encouraged and supported to work together to create or build knowledge out of their own innovations, discussions and experiences to help them solve contemporary problems.

4. What is your level of recommendation for your students with respect to OCL as a learning theory for increasing their Mathematical performance?
    - Highly recommended
    - Recommended
    - Fairly recommended
    - Not Recommended

5. Where do you teach in Sekyere East district?
    - Effiduase Senior High/Commercial School
    - Effiduasi Senior High/ Technical School
    - T. I. Ahmadiyya Grils' Senior High School
    - Krobea Asante Technical School
    - Tijjaniya Senior High School

APPENDIX C

PRE-TEST

Answer All Questions. Each Question Carries 25 Marks.

Question 1. Given $A = \sqrt{B^2C + \frac{DC}{B}}$

i. Make ***C*** the subject of the relation.

ii. If $A = 3,\ B = -2\ and\ D = 4$ find the value of x.

Question 2. The diagonal of a rectangular plot of land is $14400cm$. If the ratio of the length To the width is $7:5$, find in metres:

i. dimensions of the rectangular plot;

ii. the perimeter of the plot.

Question 3. Two regular polygons P and Q are such that the number of sides of P is 3 more than the number of sides of Q. Given the sum of their exterior angles to be 117^o, how many sides has P and Q.

Question 4. The heights of ten plants in ascending order are $12, 13, 13, x, (3-x), (52-2x), (2x-8), 23, 23\ and\ 24$. If the median height is $30cm$, find the value of x, hence, the mean height.

APPENDIX D

POST-TEST

Answer All Questions. Each Question Carries 25 Marks.

Question 1. Given $p = \sqrt{\frac{mx}{t} - t^2x}$

iii. Make x the subject of the equation

iv. If $m = 7,\ p = -3\ and\ t = 4$ find the value of x .

Question 2. The diagonal of a rectangular field is $169\ m$. If the ratio of the length to the width is $12:5$, find:

iii. dimensions of the rectangular field

iv. the perimeter of the field

Question 3. Two regular polygons P and Q are such that the number of sides of P is 3 more than the number of sides of Q. Given the sum of their exterior angles to be 117^o , how many sides has P and Q.

Question 4. The scores of ten learners in ascending order are $12, 13, 13, a, (a+3), (52-2a), (2a-8), 23, 23\ and\ 24$. If the median mark is 20, find the value of a, hence, the mean mark.

APPENDIX E

SUMMARY OF T.I. AHMADIYYA GIRLS' SHS WASSCE GENERAL MATHEMATICS RESULTS

NAME OF SCHOOL	EXAM. YEAR	NUMBER OF CANDIDATES	GRADES		PERCENTAGE OF A1-C6
			A1 – C6	D7 – F9	
T.I. Ahmadiyya Girls' SHS	2021	314	145	169	46.2%
Effiduasi Senior High/Tech.	2021	220	78	142	35.5%

APPENDIX F

SUMMARY OF T.I. AHMADIYYA GIRLS' SHS WASSCE GENERAL MATHEMATICS RESULTS

NAME OF SCHOOL	EXAM. YEAR	NUMBER OF CANDIDATES	GRADES		PERCENTAGE OF A1-C6
			A1 – C6	D7 – F9	
T.I. Ahmadiyya Girls' SHS	2022	583	560	23	96.1%