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EFFECT OF CONSTRUCTIVIST-BASED TEACHING STRATEGY ON STUDENTS' COMPUTATIONAL ABILITY IN MATHEMATICS: A GENDER STUDY IN PORT HARCOURT

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Abstract

The study investigated the effect of Constructivist-Based Teaching Strategy (CBTS) on students' Mathematical Computational Ability (MCA). It aimed to determine the difference in MCA of students taught with CBTS and Conventional Method (CM); ascertain the difference in MCA of male and female exposed to CBTS and ascertain Interaction effect between the teaching strategy and gender on students MCA. A quasi-experimental research design was employed. A sample of 240 students was selected from a population of 21,079 from 38 Public Senior Secondary Schools in the Port Harcourt Metropolis of Rivers State, using a purposive and stratified random sample technique. Data were collected using a validated Computational Ability Test (CAT) on Probability. The experimental group used CBTS, while the control group used CM. Analysis was conducted using mean, standard deviation, and analysis of covariance at a 0.05 significance level. The findings of the study revealed that the experimental group outperformed the control group in terms of MCA, as evidenced by a statistically significant difference in mean scores. Additionally, a significant difference in the mean scores of male and female students taught probability using a CBTS was seen, and MCA of the male student was favored over that of the female student by CBTS. Additionally, a noteworthy interaction impact between gender and teaching approach in MCA was demonstrated by the results. Teachers should adopt CBTS in addition to the CM to help students become more proficient computationally.

Keywords: Constructivist-based teaching strategy, Mathematics computational ability, Gender differences, Probability in mathematics.

Abstrak

Penelitian ini mengkaji pengaruh Constructivist-Based Teaching Strategy (CBTS) terhadap Mathematical Computational Ability (MCA) siswa. Tujuan penelitian ini adalah untuk menentukan perbedaan MCA antara siswa yang diajar menggunakan CBTS dan Conventional Method (CM); mengetahui perbedaan MCA antara siswa laki-laki dan perempuan yang diajar dengan CBTS; serta menganalisis efek interaksi antara strategi pengajaran dan gender terhadap MCA siswa. Penelitian ini menggunakan desain kuasi-eksperimen. Sampel sebanyak 240 siswa dipilih dari populasi 21.079 siswa di 38 Sekolah Menengah Atas Negeri di Kota Port Harcourt, Rivers State, dengan teknik sampling purposive dan stratified random. Data dikumpulkan menggunakan Computational Ability Test (CAT) yang telah divalidasi pada materi peluang. Kelompok eksperimen diajar menggunakan CBTS, sedangkan kelompok kontrol menggunakan CM. Analisis data dilakukan menggunakan rata-rata, simpangan baku, dan analisis kovarians pada taraf signifikansi 0,05. Hasil penelitian menunjukkan bahwa kelompok eksperimen memiliki kinerja MCA yang lebih baik dibandingkan kelompok kontrol, dengan perbedaan skor rata-rata yang signifikan secara statistik. Selain itu, ditemukan perbedaan signifikan dalam skor rata-rata antara siswa laki-laki dan perempuan yang diajar peluang menggunakan CBTS, di mana CBTS lebih menguntungkan siswa laki-laki dibandingkan perempuan dalam meningkatkan MCA. Hasil penelitian juga mengungkapkan adanya interaksi yang signifikan antara gender dan strategi pengajaran terhadap MCA siswa. Oleh karena itu, guru disarankan untuk mengadopsi CBTS sebagai pelengkap metode konvensional guna meningkatkan kemampuan komputasi siswa.

***Kata kunci**: Kemampuan komputasi matematika, Peluang dalam matematika, Perbedaan gender, Strategi pengajaran berbasis konstruktivisme.*

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INTRODUCTION

Mathematics is part of life and creation which helps in mental development like in logical reasoning (Ahumaraeze, 2018). Instead of focusing on manipulating objects, it is more concerned with ideas and the manipulation of symbols. It is an intricate framework with connections between concepts. Like a house of cards, mathematical concepts are connected and arranged in a hierarchical manner. Higher-level concepts cannot be understood unless lower-level ones are grasped. When students learn about some of Mathematics' structures, they are frequently struck by the subject's elegance. The selection of mathematical content and communication that leads to its comprehension and application are just as important to the teaching of mathematics as the computational proficiency of the subject. When teaching mathematics, it is important to employ pedagogical tools, tactics, and instructional methods that have proven to be considerably more effective in getting pupils to respond appropriately than in the past. Success in teaching and studying Mathematics is influenced by a variety of factors, making it a complex endeavor. In any attempt to guarantee high-quality mathematics teaching and learning, consideration must be given to the type and caliber of instructional materials, the way the content is presented, the teacher's pedagogical abilities, the learning environment, and the students' motivation (Ahumaraeze, 2018).

The study of measurement, relationships, and the characteristics of quantities and sets is known as mathematics. In these patterns and structures, logical analysis, deduction, and computation are equally important (Ekwueme, 2013). Mathematics is identified as a requirement for adequate understanding and interpreting of concepts in the social sciences; a tool that enhances the ability to think and reason logically, about the values in the changing world (Salman, 2003).

Mathematics is a required subject in both elementary and secondary education in Nigeria. In order to achieve both of Nigeria's primary school aims, preparation for life and higher education, and the goals of mathematics teaching in schools were defined. Therefore, it stands to reason that Mathematics curricula should mirror contemporary

values and attitudes. The direction of society has an inextricable impact on how Mathematics is taught in the classroom. The current age, known as the "digital era," is defined by the widespread adoption of technological solutions to a wide range of societal issues (Ahumaraeze & Nlewedim, 2025).

Mathematics has always played a major role in the existence of man from cradle upwards. Owing to its pride of place, an intellectually stimulating subject with its prongs getting into activities of politics, economy, science and technology it is a compulsory subject in the curriculum for every school age Nigeria (Iji et al., 2015). There are different aspects that come together to make up Mathematics and these include number and numeration, algebraic processes, calculus, geometry, statistics and everyday probability (Odogwu, 2014). Over the years, scholars and researchers around the world have been concerned with the factors that can aid understanding of Mathematical concepts, and how students can benefit now and always. As a result of these, several strategies and methodologies have been suggested in addition to the requirements for an effective teacher and skills in classroom management.

The aspect of these Mathematical concepts that is of emphasis in this work is Probability. Probability as a concept is hard to characterize formally (Adaramola, 2015). Defining probability in terms of the frequency of events in repeated tests is tempting, but as we will show later, this method results in a circular definition: probability would ultimately be defined in terms of probability. Probability has been seen as the likelihood of making a choice.

It is the quantity, probability, or measure of the likelihood that certain events will transpire; as a word, it is a number that represents the proportion of favorable cases to all possible cases. A probability can occasionally be expressed as a number, such as "10% chance of," or as a combination of words, such as "impossible," "unlikely," "possible," "even chance," "likely," and "certain." "It is unlikely to rain tomorrow," for instance. ‘Life in general is a probability’, stated Sam-Kayode and Salman (2015), the likelihood of having rainfall or not winning games of chance, are all probabilities. Thus, in the field of mathematics, probability deals with estimating the chance that a particular event will occur. This probability is determined by dividing the number of possible cases by the number of favorable cases. The result is expressed as a number between 1 and 0, where 0 denotes impossibility and 1 indicates certainty. For instance, there are no other

possibilities, hence the likelihood of a coin tossing up "tails" or "heads" is 1.

This study focuses on the constructivist teaching strategy which is a teaching strategy based on constructivist theory. CBTS is an approach a teacher uses to get students actively involved in the learning process by constructing their own knowledge. It is also a technique method a teacher uses to capture students; curiosity in a topic, to probe critical thinking skills, to provoke sustained and useful classroom interaction, and to facilitate their learning of course content in general. Because they actively engage in the learning process, students using CBTS are able to develop their own knowledge through discovery. The students gain ability to demonstrate the mastered basic concept; use the basic concepts to enhance creativity and improve their attitudes towards the study of Mathematics thus good performance (Adaramola, 2014; Brooks & Brooks, 1999). The constructivist perspective emphasizes the active role of learners in creating their own knowledge and believes that knowledge is about knowing and learning. It suggests that students build their knowledge via experiences.

MCA are defined as the abilities to calculate basic addition, subtraction, multiplication, and division problems quickly and accurately using mental methods, paper-and-pencil, and other tools, such as a calculator. This requires the selection of the appropriate arithmetic operation. Also, MCA require the execution of the steps to calculate the solution. MCA are the selection and application of arithmetic operations to calculate solutions to mathematical problems. Arithmetic encompasses a set of Mathematics processes that include number sense, the understanding of Mathematics principles such as the associative and commutative properties, and computational skills. Math computation skills comprise what many people refer to as basic arithmetic: addition, subtraction, multiplication and division (Harris, 2022).

Computations generally involve applying logic or mathematics to solve an issue. These can be completed by computers or calculators in addition to by humans. However, because they set the stage for success in later mathematics courses like algebra, geometry, trigonometry, and calculus, mathematical calculation abilities continue to be a crucial component of mathematics education even in the age of modern technology. The following order is typically followed when teaching MCA in the early elementary grades: addition, subtraction, multiplication, and division. Teachers frequently use games, timed assessments, and drills to enhance mathematics calculation abilities.

CBTS and students' MCA and performance

Many research findings support the positive effect of CBTS on students' MCA and performance. Ahumaraeze and Ekwueme (2019) conducted a research which focused on investigated effect of CBTS on senior secondary school students' academic performance in mathematics in Port-Harcourt Metropolis, Rivers State. A quasi-experimental research design of the pretest, post-test non-randomized and non-equivalent control group was used for the study. The study was guided by three (3) research questions and three (3) null hypotheses. A purposive stratified and random sampling technique was used to select three (3) co-educational public secondary schools. A sample of 240 (130 control, 110 experimental) students selected from 3 co-educational schools was used for the study. Two groups were used, one experimental group, and the other one is control group. The experimental group was taught mathematics with constructivist-based instructional strategy, while the other group was taught using CM (Problem Solving Strategy [PSS]). The instrument for data collection was Mathematics Academic Performance Test on Probability (MAPTP), validated with a reliability coefficient of 0.74 which was obtained through test re-test method. Data collected were analyzed using mean and standard deviation to answer the research questions. Analysis of Covariance (ANCOVA) was used to test hypotheses at α=0.05. The results showed that the experimental (CBIS) group had higher Mathematics Performance score than those in the control (PSS) group and had a significant difference in their mean scores.

Another study was conducted by Adaramola (2014), who gave a full description on the Effects of constructivist learning strategy on students' MCA in junior secondary schools in Rivers State. This study examined effect of constructivist learning strategy on students' MCA in Junior Secondary School. Research questions were answered using mean and standard deviations while hypotheses were tested using ANCOVA at α=0.05. A total of 120 students selected from 2 co-educational schools were analyzed and it was discovered that the constructivist learning strategy enhanced the students MCA, facilitate students' performance.

On the other hand, Onwuka (2015) conducted a research on effect of CBTS on students' learning outcome in mathematics where a sample of 215 students was composed with 104 assigned to experimental and 111 to control group. Out of the 104 students in the experimental group, 55 were female and 49 were male. The control group of 111

consists of 60 and 51 females and males respectively. The result of the study revealed that those in experimental group performed significantly better.

Also, in another study by Angraini et al. (2024) which analyse the mathematical computational thinking ability of Mathematics Education study program students in terms of constructivism learning theory. The main focus of this research is to understand how the constructivist learning approach affects the development of students' MCA. This research is qualitative descriptive research. It explores students' learning process in the context of developing computational understanding and application of computational concepts in mathematics education. This research was conducted in the Department of Mathematics Education on students who took the Algebraic Structure course in the 2023/2024 academic year. The subjects of this research amounted to 34 students. The findings of this study provide insight into the effectiveness of constructivism learning theory in improving MCA of Mathematics Education students. The results showed that students' average MCA was good, and descriptively, the prior mathematical knowledge could also differentiate students' MCA in terms of constructivism learning theory.

Furthermore, Asrianti and Rakhmawati (2024) observed after analysis of effect of Problem-Based Learning Model on Students' MCA. The conclusion reached is that there is a significant effect of using Problem Based Learning model on students' MCA. The sample of this study involved 8th grade students of Madrasah Tsanawiyah (MTs) Hifzhil Qur'an Yayasan Islamic Centre Sumatera Utara in the 2023-2024 school year totaling 53 people. The sampling technique used was cluster random sampling so that researchers had 2 class groups, namely class 8-3 as the experimental class and class 8-4 as the control class. The method used is quantitative experimentation with a research design in the form of true experimental design in the form of post-test-only control design. The analysis of this study used *t*-test and obtained Sig.<0.001.

Hartawan et al. (2024) looked at Junior High School Student's MCA in solving mathematical problems. The results of this study are (1) MCA of grade VII junior high school students is classified as medium with the percentage of each component of MCA is 47.25% (decomposition), 35.25% (pattern recognition and generalization), 50.38% (abstraction), and 29.88% (thinking algorithms); (2) Obstacles faced by students in solving mathematical problems that cause students who have MCA, categories including students who are not accustomed to sorting information as activities in the components

of abstraction skills and the core of MCA. The implications of these findings suggest that research subjects in the lower category MCA have a tendency to struggle in mastering the abstraction skill component.

Also, Angraini and Muhammad (2023) conducted a research on analysis of students' MCA in prior mathematical knowledge. The research was motivated by the importance of MCA for students to get a better thinking and problem solving abilities. The purpose of the study describes the students' CT ability in terms of their prior knowledge. The subjects of this study were 6 junior high school students consisting of 2 students who had a high prior knowledge, 2 students who had a medium prior knowledge, and 2 students who had a low prior knowledge. The selection of subjects was not randomly selected. The method of research used was descriptive qualitative, where the data presented were deepened by interviews. Furthermore, the instruments used were test and non-test. In this case, the CT test was used to determine students' CT ability in terms of their prior knowledge, while the non-test in the form of interviews was used to find out the reasons for their test answers. The results of this study indicate that students who had a high prior knowledge were able to meet the CT mathematical indicators well. Furthermore, students who had a medium prior knowledge were able to meet several mathematical CT indicators, while students who had a low prior knowledge cannot fulfill mathematical CT indicators well.

Gender and CBTS

Adaramola (2014) discovered that girls performed better than boys in the constructivist learning as an Instructional Strategy and the result shows that there is no significant difference in the performance of male and female students taught with CBTS since the critical value is greater than the calculated value.

Another study was conducted by Onwuka (2015) who gave a full description on effects of CBTS on students learning outcome in Mathematics. In terms of gender, there was no significant difference in the performance of the students taught using CBTS but the female students performed slightly better than the male. It was recommended that Mathematics teachers should be retrained in modern instructional strategies such as CBTS.

Also Ahumaraeze and Ekwueme (2019) revealed that there is a significant difference

in the mean scores of male and female students taught probability using CBTS and it favored the male than the female in performance. A sample of 240 (130 control, 110 experimental) students selected from 3 co-educational schools was used for the study.

Furthermore Akpan et al. (2022) investigated the effects of GeoGebra-Supported Model Based Learning (GSMBL) on students' academic performance in Solid Geometry in Uyo Metropolis of Akwa Ibom State, Nigeria. The results of the study shown that gender had no significant effect on students' academic performance when taught the concept of Solid Geometry using the two teaching strategies. This was attributed to active involvement, equity, and inclusiveness of all learners during the learning processes. Male and female showed equal cognitive abilities, adaptation and accommodation in a dynamic-interactive learning environment.

Gamage and Charles-Ogan (2019) discovered that the male students in the experimental group who were taught circle geometry using GeoGebra software had a pre-test mean value of 19.50 and standard deviation of 11.99 while the female students in the experimental group had a mean value of 20.31 and standard deviation of 12.01. For the post-test mean score, male students obtain a mean of 53.95 and standard deviation of 7.17, while the female students obtain a mean performance score of 55.96 and standard deviation of 5.81. The mean gain scores for the two groups were 34.45 for male and 35.65 for female students respectively. Also, the difference in the mean gain scores of both groups was established at 1.20. There was no significant difference between the mean performance of the male and female students taught circle geometry using the GeoGebra software.

Interaction effect of teaching strategy and gender on mathematics performance

The result showed that the experimental (CBTS) group had higher Mathematics Performance score than those in the control (PSS) group and had a significant difference in their mean scores (Ahumaraeze & Ekwueme, 2019). It also showed a significant difference in the mean scores of male and female students taught probability using constructivist-based instructional strategy and CBIS favored the male than the female in performance. The result also showed a significant interaction effect between Gender and instructional strategy in Mathematics academic performance. Their researcher work is titled "Effect of CBTS on senior secondary school students' academic performance in

Mathematics in Rivers State, Nigeria". Their study focused on investigated effect of CBTS on senior secondary school students' academic performance in Mathematics in Port-Harcourt Metropolis.

According to Adaramola (2014), who in the research work shows that there are significant interactions between the teaching methods and gender for students' performance and not the MCA in solving Problems in Mathematics since the MCA is not significant.

Moreover, Macaulay and Obafemi (2022) in their findings also shows the interaction of gender and group/instructional strategy on students' performance. It reveals that at $F_{(1,79)}$=2.055, *p*-value=0.156 (*p*-value>0.05), gender is not significant; at $F_{(1,79)}$=22.516, *p*-value=0.00 (*p*-value< 0.05), group/strategy is significant and at $F_{(1,79)}$=0.144, *p*-value=0.705 (*p*-value>0.05), the interaction of group and gender is not significant. The null hypothesis is thus retained that there is no significant joint effect of gender and strategy on the performance of students in the concept of Electrolysis. There is however no significant joint effect of gender and strategy on the performance of students in the concept of Electrolysis.

Anietimfon (2020) in their findings revealed that significant interaction effect existed between the mean performances of scores of students taught Mathematics with the peer learning strategy and those taught with the traditional conventional technique. Also, boys and girls taught by the peer learning strategy were positively affected in knowledge and improved performance. Zalmon and Nwagor (2015) revealed that the interaction effect between gender and strategy was not significant. The Gender comprises of 41 male, 39 female (21 male and 19 female in the PBL group while 20 male and 20 female in the CTS).

Frederick-Jonah et al. (2022) in their study shown by the 2-way interaction of instructional strategies on gender and birth order ($F_{(1,83)}$=0.446; *p*-value=0.506>0.05; partial eta squared = 0.005 which gives an effect size of 0.5 percent) and ($F_{(1,83)}$=0.118; *p*-value=0.732>0.05; partial eta squared = 0.001 which gives an effect size of 0.1 percent) respectively. The findings showed that YouTube videos' instructional strategy improved students' achievement in Mathematics equally despite differences in gender and birth order. It was recommended among others that, teachers should integrate YouTube videos in instruction to improve students' achievement and to eliminate gender and birth order

differences in Mathematics among secondary school students.

From the Empirical review, it was observed that CBTS was used by few researchers on students' performance but none was done on students' MCA. It was also observed that various Mathematics concepts have been taught using the CBTS. The review found out that researchers have conducted some studies on use of CBTS to teach various Mathematics concepts in various areas but none was conducted in Port Harcourt Metropolis of Rivers state to the researcher's best of knowledge. Empirically there is a seeming disparity on gender issues as it relates to male and female students' performance in Mathematics and much of these works have not touched CBTS which this work focused on. This constituted a gap which this study intends to fill. This study was conducted in Port Harcourt Metropolis of Rivers State to find out the effect of CBTS on students' MCA in Probability.

Statement of the problem

It is concerning how frequently students these days fail Mathematics examinations, both internal and external, WAEC chief examiners see the failure rate as deteriorating year after year. Researchers and educators have been concerned about how to improve students' low performance in Mathematics. Several variables are responsible for this; ranging from the learners themselves, the teachers' attitude to teaching as a profession, textbooks, curricula, school environment, teachers' methods of teaching etc (Adaramola, 2014).

Gender issues globally, have generated a lot of conflicting and inconclusive results in Mathematics among educationists and researchers. Results of some studies indicate significant difference in the performance of female and male students in Mathematics, others show contrary results; this gives rise to further research works on gender.

Aim, research questions, and hypotheses

This study aims to investigate the effect of CBTS on students' MCA. Specifically, it seeks to: (1) determine the difference in MCA of students taught with CBTS and CM; (2) ascertain the difference in MCA of male and female exposed to CBTS; (3) ascertain Interaction effect between the teaching strategy (CBTS) and gender on students MCA.

To achieve these objectives, the study is guided by the following research questions:

(RQ1) What differences exist between the CBTS and CM on students given their CAT?; (RQ2) What differences exist between the CAT of male and female students taught Mathematics Using CBTS?; (RQ3)What is the Interaction effect between the teaching Strategy (CBTS) and gender on students MCA?

The following hypotheses were formulated and tested at a 0.05 significance level: (H01) There is no significant difference between MCA of students taught with CBTS and those taught using CM, (H02) There is no significant difference between MCA of male and female students taught Mathematics with constructivist- based teaching strategy, (H03) There is no significant Interaction between the teaching strategy (CBTS) and gender on students MCA.

RESEARCH METHODS

In other to achieve the three objectives of the study which are to determine the difference in MCA of students taught with CBTS and CM; ascertain the difference in MCA of male and female exposed to CBTS; and ascertain Interaction effect between the teaching Strategy (CBTS) and gender on students MCA, the following methods were used to achieve the objectives.

This study uses a pre-test, post-test control group in a quasi-experimental approach. To avoid interfering with regular school operations for experimental purposes, intact classrooms were employed. A quasi-experimental study is one in which some challenges to validity cannot be adequately managed as human subjects are being used in the experimental investigation (Nwankwo, 2013). The study used a control group design with a pre-test and post-test phases. The experimental group received instruction utilizing a CBTS, while the control group received instruction using CM. The majority of secondary school Mathematics teachers currently employ CM. The students received treatment in the form of classes that focused on the specific aspects construct in order to improve their performance.

The study were carried out in Port Harcourt Metropolis, with geographical coordinates of latitude 4° 40' E and longitude 7° 10' E (http://www.mapsofworld.com/lat_long/nigeria-lat-long.html). The area of the study is suitable because it is an environment that largely urban areas, with all social classes of people present. It is bordered on the East by Etche, Eleme and Oyibo L.G.A, on the west

by Asari-toru and Abual/Odual L.G.A, on the north by Ikwerre and Emuoha L.G.A, and on the south by Bonny, Okrika and Ogu/bolo L.G.A. The people are mostly landlords, academicians and business people. The educational activities in the area are very high because many of the tertiary institutions in Rivers State are located in the area (The University of Port Harcourt, Rivers State University, Ignatius Ajuru University of Education, Port Harcourt Polytechnic, School of Health and School of Nursing) and a lot of Primary and Secondary (both Privates and Government). In the light of this, the findings of this study can be easily generalized within the state, and its relevance will be intact.

The study's population consists of twenty-one thousand and seventy-nine (21,079) Senior Secondary Students two (SS2) (Male = 9699, Female = 11,380) of the thirty-eight (38) Senior Secondary Schools in the Port Harcourt Metropolis of Rivers State (Planning, Research, 2022). Three schools were chosen for the study using a stratified random sample approach with a purposive component. Among the selection criteria are: At least two (2) Mathematics teachers, one of whom teaches the subject in senior secondary school 2 courses, must be present for the Senior Secondary School Certificate Examinations for a minimum of 10 consecutive years in each school. A total of 240 (two hundred and forty) senior school 2 Mathematics students from the three coeducational senior secondary schools in the Port Harcourt Metropolis made up the sample. Two groups, the experimental group and the control group were created from the samples. The selected sample had 110 students (Male=56; Female=54) for the experimental and 130 students (Male=70; Female=60) for the control group respectively.

An instrument and lesson plans based on each strategy were used for the study. The instrument designed for data collection titled CAT on Probability. The Instrument was developed by the researcher taking into consideration the different aspects of probability.

The treatment was administered within three weeks after the initial test. In order to achieve best results, the researcher had several sessions with the teachers (research assistants) through phone calls and face to face contact. The research assistants were guided on the use of the lesson plans for the study. The staff of the sample school was used to avoid teacher-researcher variable. Two lesson plans were used for the study. Lesson plans were prepared; one for CBTS group (experimental group) and the other for the control group (CM).

The Teachers taught these different groups at different Mathematics lesson times in their different schools for periods of 80 minutes for two weeks. Then the Post-test was administered to the students after teaching. The regular school Mathematics teachers helped in class control and administration of the tests. The data obtained was subjected to analysis.

Face and content validation of the items in the instrument was done by two experts from University of Port Harcourt since the item questions were drawn from standardized test items from WAEC past questions. The instrument was critically looked at by the experts and confirmed valid.

The test retest reliability method was used. Correlating the students' response for the 1st and 14th day using Pearson product moment correlation coefficient statistics, the reliability index of 0.74 was obtained. The instrument Mathematics Achievement Test on Probability (MATP) was judged reliable for the study. In view of the test and retest done for the data gathering, the post-test question were re-shuffled although retaining its content in order to avoid labeling by the students, when the test was administered again.

The data was analyzed through the use of mean (M) and Standard deviation (SD) for the research questions. The ANCOVA at p-value ≤ 0.05 probability level was used for the testing of the hypotheses. ANCOVA is appropriate due to the influence of removing the confornding variables that affects the true effect of the independent variable using pre-test as covariate.

RESULT AND DISCUSSION

The research findings are presented in each subsection based on the research questions and hypotheses.

Effect of teaching strategy on students MCA

RQ 1 examined the difference that exist between the CBTS and CM on students' given their CAT. The results of the descriptive statistical analysis of students' MCA scores based on the teaching method groups are summarized in Table 1.

Based on Table 1, students taught with CBTS achieved MCA mean gain significantly higher (M=54.22) than those taught via CM (M=32.20). The data analyzed on Table 1 showed that CBTS enhances students' MCA and also revealed that the students in

experimental group had a good MCA than the control group students.

Table 1. Mean and Standard Deviation MCA of Students' taught using CBTS and CM

Group	N	Pre-CAT		Post-CAT		Mean Gain
		Mean	SD	Mean	SD	
CBTS	110	10.91	19.87	65.13	18.91	54.22
CM	130	14.50	21.15	46.70	19.37	32.20
Total	240	12.85	20.61	55.15	21.22	42.30

To determine whether this observed difference is statistically significant, H01 was tested. The results of the analysis testing H01 are presented in Table 2.

Table 2. ANCOVA Summary on Students MCA with CBTS and CM

Source	Type III Sum of Squares	*df*	Mean Square	$F_{calc.}$	*Sig.*	Partial Eta Squared
Corrected Model	34885.056	2	17442.528	56.858	.000	.324
Intercept	448400.726	1	448400.726	1461.677	.000	.860
Pre CAT	14652.679	1	14652.679	47.764	.000	.168
Group	23185.261	1	23185.261	75.578	.000	.242
Error	72704.840	237	306.771			
Total	837445.000	240				
Corrected Total	107589.896	239				

In Table 2. The results shows there is significant difference in MCA ($F_{(1,237)}$=75.578, *p*-value= 0.000) scores of students taught with CBTS and CM.

Upon further statistical analysis as found in Table2, it was discovered that there was a significant difference in the MCA of students taught with CBTS & CMT. This finding is in support of Adaramola (2014), where constructivist learning strategy enhances students' MCA over CM and also Asrianti and Rakhmawati (2024) whose result reveled that there is a significant effect of using Problem Based Learning model on students' mathematical computational thinking skills.

Gender Differences in MCA with CBTS

RQ2 explore whether there is a differences in CAT of male and female students' taught mathematics using CBTS in the experimental group. The results of the descriptive statistical analysis of students' retention scores based on gender groups are summarized in Table 3.

It is evident from Table 3 that the CBTS favored the male than the female counterpart in MCA. The male had a mean of 60.04 while the female had a mean of 48.17 in the same

experimental group.

Table 3. MCA Scores by Gender (Male and Female)

Variable	Gender	N	Pre-CAT		Post-CAT		Mean Gain
			M	SD	M	SD	
CBTS	Male	56	9.60	18.43	69.64	15.26	60.04
	Female	54	12.27	21.34	60.44	21.20	48.17
	Total	110	10.91	19.87	65.13	18.91	54.22

To determine whether this observed difference is statistically significant, H02 was tested. The results of the analysis testing H02 are presented in Table 4.

Table 4. ANCOVA summary of male and female students' MCA with CBTSA.

Source	Type III Sum of Squares	*df*	Mean Square	$F_{calc.}$	*Sig*.	Partial Eta Squared
Corrected Model	3443.696	2	1721.848	5.187	.007	.088
Intercept	336212.680	1	336212.680	1012.902	.000	.904
Pre CAT	1117.668	1	1117.668	3.367	.069	.031
Gender	2531.369	1	2531.369	7.626	.007	.067
Error	35516.523	107	331.930			
Total	505532.000	110				
Corrected Total	38960.218	109				

In Table 4, the result revealed that there is significant difference in MCA ($F_{(1,107)}$=7.626, *p*-value=0.07) of male and female students taught Mathematics with CBTS. The null hypothesis was rejected and the alternative hypothesis was accepted.

It was further subject to statistical analysis as shown in Table 4. The result showed that there is a significant difference in the MCA of male and female students taught Mathematics with CBTS. This finding where in disagreement with Adaramola (2014) who discovered that girls had better MCA than boys in the constructivist learning as an instructional strategy and the result shows that there is no significant difference in the performance of male and female students taught with CBTS since the critical value is greater than the calculated value.

Interaction effect of teaching strategy and gender on MCA

Research Question 3 explores whether there is Interaction effect between the teaching Strategy and Gender on Students MCA. The results of the descriptive statistical analysis of students' retention scores based on gender groups are summarized in Table 5.

Table 5. Interaction effect between the teaching strategy and gender on students MCA

Group	Gender	N	Pre-CAT		Post-CAT		Mean Gain
			M	SD	M	SD	
CBTS	Male	56	9.60	18.43	69.64	15.26	60.04
	Female	54	12.27	21.34	60.44	21.20	48.17
	Total	110	10.91	19.87	65.13	18.91	54.22
CM	Male	70	11.82	20.58	44.13	19.22	32.31
	Female	60	17.63	21.55	49.70	19.27	32.07
	Total	130	14.50	21.15	46.70	19.37	32.20
Total	Male	126	10.83	19.61	55.47	21.64	44.64
	Female	114	15.08	21.52	54.79	20.82	39.71
	Total	240	12.85	20.61	55.15	21.22	42.57

Based on Table 5, it revealed that the experimental group has a mean gain of 54.22 while the male and female in the group has its gain as 60.04 and 48.17 respectively. The control group had 32.20 (male had 32.31, female had 32.07). In all (both experimental and control groups) had mean gain of 42.57.

To determine whether this observed difference is statistically significant, H03 was tested. The results of the analysis testing H03 are presented in Table 6.

Table 6. ANCOVA summary of teaching strategy-gender interaction on students' MCA

Source	Type III Sum of Squares	*df*	Mean Square	$F_{calc.}$	*Sig.*	Partial Eta Squared
Corrected Model	38097.152	4	9524.288	32.208	.000	.354
Intercept	443521.007	1	443521.007	1499.832	.000	.865
Pre CAT	14535.890	1	14535.890	49.155	.000	.173
Group	22591.474	1	22591.474	76.396	.000	.245
Gender	690.789	1	690.789	2.336	.128	.010
Group*Gender	2710.665	1	2710.665	9.167	.003	.038
Error	69492.743	235	295.714			
Total	837445.000	240				
Corrected Total	107589.896	239				

In Table 6, The Interaction effect between teaching strategy and gender on students' MCA was significant ($F_{(1,235)}$=9.167, *p*-value=0.003<0.05).

The teaching strategy used for the experimental group increase (enhance) students' (male & female) MCA. It shows that there was interaction effect between teaching strategy and Gender. Further statistical testing, as indicated in Table 6, indicated significant interactions between gender and the instructional style on students' MCA ($F_{(1,235)}$=9.167, *p*-value<0.05) while solving Mathematics problems.

This position is supported by Macaulay and Obafemi (2022), Ahumaraeze and

Ekwueme (2019), Adaramola (2014), Anietimfon (2020) who found that there is an interaction between the Gender and Strategy on students' performance score and debunks Badru (2022); Jolaosho et al. (2020); Agwagah et al. (2019); Bupo (2019); Zalmon and Nwagor (2015) who revealed that the interaction effect between gender and strategy was not significant.

CONCLUSION

Students can compute more effectively using CBTS than with the traditional approach. If students are to benefit from any learning sequence, they must be in charge of their own learning. Due to the fact that CBTS allowed students to study at their own pace and through peer cooperation, even those with weaker MCA were able to develop and do better early. The students actively participate and create their own knowledge. It is crucial for encouraging students to think creatively and unconventionally when solving difficult Mathematics issues. Students' MCA (in probability) was aided and improved by CBTS. Additionally, it had a statistically significant impact on MCA of pupils learning probability.

Using CBTS to teach probability, students' performance and computing skills were also statistically significantly impacted by gender. Male was preferred by CBTS. If the teaching approach is solely focused on CM, boys will always have an edge over girls. Instead, CBTS will enable boys to think more effectively. The findings indicate a relationship between gender and the teaching method and students' computational proficiency.

The following recommendations were made based on the findings of the study: (1) teachers should shift from CM and CBTS to enhance students' MCA in schools; (2) the Mathematics teachers should consciously introduce the CBTS in teaching Mathematics concepts as a way to boost retention of concepts; (3) CBTS should be encouraged among learner in order to help the weak ones develop rapidly and speedily, it will also encourage team work allow them to construct their own knowledge; (4) CBTS should be incorporated in the Mathematics curriculum for the pre-service teachers' programme

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