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INVESTIGATING THE IMPACT OF COMPUTATIONAL THINKING INTEGRATION ON MATHEMATICAL PROBLEM-SOLVING SKILLS OF SENIOR SECONDARY SCHOOL STUDENTS IN AKURE SOUTH LOCAL GOVERNMENT AREA OF ONDO STATE

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Abstract

Human beings are all just thinking creatures, whether consciously or unconsciously. This means that mankind will always think. Human beings themselves have had to amass reason and wisdom based on these tools that they depend upon for survival. Thus, the goal of this research is to investigate whether Instruction in mathematical problem-solving methods based on principles of Computational thinking can help raise academic performance among senior secondary school students. In terms of the design, the study used a non-randomization pretest-posttest control group quasi-experiment. This study randomly assigned 105 students each; to experimental and control classes. Therefore, the direction of this research proceeds from quaternary questions and a quaternary hypothesis. Data were collected using a Posttest Mathematics Accomplishment Test (PMAT) designed by the researchers. Statistical Package for Social Science version 23 was used to analyze the data. The study questions were answered descriptively using mean and standard deviation, and the hypotheses were assessed using a student's t-test with an alpha-level coefficient of 0.05. The experiment shows that students in the experimental group performed better after testing; even though the two groups were on the same level before the experiment. However, the scores of male and female students in the experimental group turned out not to be too far apart. On the ability to retain the skills learned longer, the findings revealed that students in the experimental group did better than those in the control group. Based on this, it was therefore suggested, among others; that basic computational thinking be included in secondary-school education.

Keywords: Investigating the Impact, Mathematical Problem-Solving Skills, Computational Thinking Integration, Senior Secondary School Students.

INTRODUCTION

Computational Thinking (CT) is a relatively new concept in thinking and intelligence which borrows its concepts and methods from computer science. As Wing (2006) explains, it involves applying the fundamental principles of computer science to develop systems and understand human behavior to solve problems. This involves working on hard problems, which a computer may be able to help with if properly programmed. It also relies explicitly upon method and organized thinking in problem-solving as well as rational thought processes. Cuny, Snyder & Wing (2011) describe the concept of computational thinking as finding answers to questions in

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a form that can be executed by computers. Thus defined, computational thinking involves a process that includes issues and solutions as well. Wing (2011) defined computational thinking as the ability to cast problems in terms of a sequence of operations which can be turned into methods and formulas. This can be seen from a variety of perspectives, but it essentially consists of the following key elements: Decomposition (breaking a problem down into smaller parts), pattern recognition, abstraction (assessing only the valuable and ignoring all else trivial or irrelevant) use of step-by-step procedures known as an algorithm (Wing, 2006; Kalelioglu, Gulbahar & Kukul 2016; Vassallo & Busuttil, 2022; Atmatzidou & Demetriadis, 2016). Wing (2006) suggested that CT is a transferable skill which may be applied in several different sectors and not just computer science. This promotes a rational method of solving problems, enabling people to think clearly and prioritize information, as well as providing them with an effective response. In today's digital world which is ever more driven by data (Vassallo & Busuttil 2022), it helps lay the groundwork for success in any future profession or career.

According to Neslihan & Nihal (2021), students need to develop the skill of thinking like a computer to participate in life today. This is because, as outlined in the study by Camilla Milander et al. (2023) in the area of education abroad that uses computer transformation, CT is a technique that can be utilized by computers to identify and solve issues. It is important at all stages of education and across all domains. So, computational thinking is a way of resolving complexities through logical reasoning and breaking down the problem into smaller parts before finding a solution right. This method will have a good effect on cognitive abilities like critical thinking and problem-solving. This is a very important skill in computer science that we should all learn. It has many uses and is essential in almost any field. In their study, Bocconi et al. (2016) stated that as technology affects our daily routine, it is becoming essential for employees in various sectors to learn how to think digitally.

Mustafa and Mehme (2008) say that problem-solving is the process of dealing with problems. They argue that this is the purpose of any scheme aimed at helping students deal with mathematical problems their ability to identify and solve issues accurately, as well as stimulating a willingness to try new things for oneself and increasing determination when grappling with difficult concepts. Solving an extremely difficult problem requires the students' skills to be at a certain level, which can make them frustrated and less willing to continue working on solving problems. On the other hand, students will be inspired to try more problems when they get them right. Thus, the task should be making sure that children develop a liking for solving mathematical problems. In the twenty-first century, one way of doing this is to give them concepts related to computational thinking.

Promoting analytical reasoning, critical thinking and well-organized decision-making skills by helping to cultivate mathematical problem-solving abilities which are part of the requirements for excellent performance in mathematics alone can be so important from various points of view. When someone is sufficiently adept at mathematical questions, they can decompose hard problems to find the required information and follow logical processes for a solution (ISTE. 2016). These capabilities go far beyond mathematics. They are applicable in all kinds of disciplines, enabling people to make correct decisions and guiding them toward how they

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should plan a strategy or not be tempted by obstacles along the way. However, despite reservations about the value of mathematics in daily life, strong mathematical problem-solving abilities are especially important for careers such as Science, Technology, Engineering and Mathematics (STEM), but also relevant to economics or data science. Thus, for a society to achieve technological advancement, the youth of that nation must be able to solve mathematical problems and if one doesn't have good computational thinking concepts there is no way they can go about solving them.

In today's data-driven and technology-focused society, solving mathematical problems is the key to understanding; you won't be able to catch up otherwise (Abe & Olojo 2023). By enabling people to analyze, assess and understand numerical information, it promotes quantitative literacy. Aside from practical applications, developing the ability to solve mathematical problems encourages the growth of one's thinking capacity. In turn, this cultivates flexibility as well as a logical attitude toward dealing with all manner of difficulties. In short, these skills are central to survival in school and work--not only in the workplace of today but that of tomorrow. As society becomes more complex, we're becoming increasingly data-driven. Computational thinking (CT) is therefore a necessary ingredient of the teaching and learning environment because it offers an organized, systematic approach to solving problems that are compatible with basic mathematical reasoning (Camilla et al., 2023).

Computational Thinking (CT), with its association with mathematical thinking and its importance here in the twenty-first century, is increasingly becoming a necessary part of mathematics education. By using CT in mathematics classes, students develop such abilities as deconstruction, pattern identification, abstraction and algorithmic thinking which improve their ability to solve difficult mathematical problems. In addition, explains Hickmott, Prieto-Rodriguez and Holmes (2018), CT allows students to break down mathematical problems into manageable pieces; and shows them the pattern of presentations in mathematics structures. It also provides for a critical abstraction from information key ideas and constructs systematic approaches to problem experience or question machines that can be reused their knowledge of mathematical concepts expands, and the students learn skills they can transfer to both academic endeavours and real-world situations. Bringing CT into mathematics teaching could help students cultivate a psychology conducive to logical thinking and speedy problem-solving, skills crucial in all aspects of life. It would also help them prepare themselves for the digital age. Hence, it would not be wrong to consider mathematics and computational thinking as the “inseparable twins."

Studies reveal that secondary school students always perform so poorly on mathematics examinations such as West African Senior School Certificate Examination (WASSCE) and National Examination Council (NECO) because they lack several of Computational Thinking's necessary elements. Hence, this study aimed to discover how integrating Computational Thinking into Secondary Education could influence Students 'Mathematical Problem-Solving abilities. This study has important consequences for educational philosophy and practice. Research into whether the concepts of computational thinking impact how secondary school students solve mathematics problems could be extremely instructive and may inform our ideas

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about curricula, and teaching methods. Secondly, educators can create better lesson plans by understanding how computational thinking improves one's problem-solving ability. Wider educational implications arising from the findings can provide a fact-based basis for including computational thinking in the secondary school mathematics curricula. In the Digital Age, computational thinking is increasingly recognized as an important skill. Giving Mathematical Computational Thinking a concrete direction, this study suggests that instructional strategies should be refined to better prepare students for the demands of educational and professional life in an advanced technological society.

Objectives of the Study

This paper explores how students 'development of mathematical problem solving skills is affected by incorporating principles underlying computational thinking into the mathematics curriculum for secondary school students. The study will specifically look into:

1) Compare the average performance scores of students who were taught Mathematical Problem-Solving Skills following Computational Thinking principles before and after testing.
2) Test the average performance scores of students taught Mathematical Problem Solving Skills by standard versus Computational Thinking approaches.
3) Differences in mean performance scores for male and female students of mathematics, given Mathematical Problem-Solving Skills instruction using Computational Thinking.
4) Compare the remembering ability of students trained in Mathematical Problem-Solving Skills according to Computational Thinking principles with those taught by the traditional method.

Research Questions

The following four research questions were generated for the study:

1) Is there any difference between the mean performance scores of students taught Mathematical Problem-Solving Skills utilizing the Computational Thinking principles and conventional method in pre- and post-test?
2) Is there any difference between the mean performance ratings between students who learnt Mathematical Problem-Solving Skills using conventional and Computational Thinking methods?
3) Is there any difference between the mean performance score of male and female students who were taught Mathematical Problem-Solving Skills using the Computational Thinking principles?
4) Is there any difference between the capacity to remember knowledge by the students taught using Mathematical Problem-Solving Skills utilizing the Computational Thinking principles and those taught in the traditional way?

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Research Hypotheses

The following four hypotheses were formulated from the above research questions and tested at 0.05 level of Tolerance Limit of errors.

1) **H_{01}:** There is no significant difference in the mean performance scores of students who were taught Mathematical Problem-Solving Skills utilizing the Computational Thinking principles and Conventional method in the Pre-test.
2) **H_{02}:** There is no significant difference in the mean performance scores of students who were taught Mathematical Problem-Solving Skills utilizing the Computational Thinking approach and those taught the same skills utilizing the conventional methods.
3) **H_{03}:** There is no significant difference in the mean performance scores of Male and Female students who were taught Mathematical Problem-Solving Skills utilizing the Computational Thinking principles.
4) **H_{04}:** There is no significant difference in the retentive ability of students who were taught Mathematical Problem-Solving Skills utilizing the Computational Thinking principles and those taught the same skills utilizing the conventional approach.

LITERATURE REVIEW

Influenced by the development of Information and Communication Technologies, education scholars now more frequently promote technology-enhanced learning in mathematics. Now, those elementary school teachers are looking closely at it, once very popular in secondary schools and higher education (Tikva & Tambouris, 2021). As the ability to think computationally becomes increasingly important in elementary schools, students can use it as a method for coming up with solutions and extending their view of what life is all about (Fagerlund et al., 2021). Today, researchers who want to add computer technology applications into mathematics curricula for elementary school elect to do so; so that they can provide support for CT education Rodriguez-Martinez et al. (2020) and Rich et al. (2019) posited that because children in technologically advanced countries such as China and Japan have been exposed to Computational Thinking at an early age, kids from those nations are good students of science and mathematics. In turn, their ICT performance is high as well because it involves technology. Unfortunately, the children of sub-Saharan Africa are giving lip service to Computational Thinking which brings underdevelopment as a side effect. Their study resulted in the conclusion that CT has very good matches with mathematics curricula; making it convenient to introduce CT into secondary school education curricula.

CT in education also helps to cultivate the mental alertness of children. The whole encompasses several major elements. Each contributes to a comprehensive form of critical thinking and problem-solving. The most important aspect is Problem Decomposition; where students learn how to solve complex problems by breaking them down into smaller parts. This method encourages a systematic approach that emphasizes breaking complex problems down sequentially. The other important component is pattern recognition, which involves

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recognizing similarities or recurring patterns within data, problems etc. This skill enables students to understand structures, making them more adaptable in solving problems under different circumstances. Besides training students to bring information down from the clouds and make it easier for problem-solving, and understanding clarity; pattern recognition is an abstraction. Abstraction is another CT component that helps students focus on core concepts and disregard peripheral details, to arrive at more elegant solutions (Barr & Stephenson, 2011; Selby & Woollard, 2013; Angeli et al., 2016; Javier et al., 2023; Çetin & Toluk-Uçar, 2020).

Algorithm or creating step-by-step solutions or rules to solve a problem is another important part of Computational Thinking. This component encourages the development of systematic, economical procedures for solving problems in a logical order. Meanwhile, a third element is logical reasoning--the ability to make decisions based on reasoned argument and evidence. It develops the ability to think critically, allowing students to distinguish among choices and notice cause-and-effect relationships. Computational Modeling explains the idea of creating and using models to represent real-world phenomena. This aspect uses such things as simulations or models to expand one's understanding of complicated systems and encourages practical and applied learning. Algorithmic Efficiency is a subcomponent which focuses on finding the most efficient way to solve a problem and encourages students to optimize how they approach problems, thinking carefully about time spent or resources used (Selby & Woollard, 2013; Angeli et al., 2016; Çetin & Toluk-Uçar, 2020).

Working effectively with people and expressing ideas are two important elements Collaboration and Communication. These components encourage teamwork and stress good communication in solving problems. Finally, there is the term Real-World Applications which belongs to Computational Thinking in Education. This part illustrates the usefulness of computational thinking in all areas and prepares students for practical applications throughout their lives, thus filling the divide between book knowledge and practice. These major components of Computational Thinking in Education as a whole prepare students to deal with things systematically and think deeply, work together collaboratively, and easily change direction depending on the situation (Barr & Stephenson, 2011; Selby & Woollard, 2013; Angeli et al., 2016; Javier et al., 2023; Çetin & Toluk-Uçar, 2020).

Despite being an emerging concept, computational thinking is a quickly evolving notion; in recent educational advancements, Computational Thinking (CT) and its incorporation into the curriculum have received great attention. Numerous studies have looked at the advantages of teaching CT at a young age in the literature. Chen et al. (2017) discovered, for instance, that teaching elementary students CT improved their capacity to abstract, reason, and solve issues about a wide range of learning-related topics in their daily lives. According to a 2015 study by the International Society for Technology in Education (ISTE), CT not only improves elementary students' use of computers and other digital tools (such as robotics kits and sensors) to solve problems, but it also fosters creativity and critical thinking in them as they work through hands-on projects. Israel, Pearson, Tapia, Wherfel, and Reese (2015) looked at the best ways for teachers of primary school pupils who had little background in computer science to include CT in their lessons. It was determined by them that elementary school teachers may organize and arrange exercises to include CT in their lesson plans. A study was carried out by Gonzalez, Gonzalez, and Fernandez (2016) to propose a definition of CT appropriate for scientific and mathematics instruction. After identifying the terms "modelling," "system design," "simulation," and "problem-solving with CT" in this description, they concluded that CT abilities ought to be covered in the scientific and mathematics curricula. Kirwan, Costello, and Donlon (2018) conducted a study to find out how well secondary school teachers can instruct students in online and CT courses. They concluded that with CT, one might use it to create video games, play them, and learn non-visual programming languages, and carry out a variety of other tasks that would help one succeed in an online setting. All of these instances show how mathematical ideas and CT may be taught to students in a block-based learning environment, and how CT can play a significant part in the teaching of mathematics.

Everyone should have the ability to solve problems. Problem solving skill provides students a chance to apply their mathematics knowledge and skills in solving problems that arise within the social world. The use of mathematical thoughts, techniques and terms to solve real-world problems is what we call the mathematics problem-solving process. It advocates using mathematical thinking to address and deal with the original problems instead of just mechanical rote memorizing of formulas. This skill set involves getting to the point: finding relevant information, defining a concise problem narrative, developing a coherent attack strategy and drawing conclusions in the light of the big picture (Osman et al 2018). The solving of problems in mathematics is not limited to any one branch of mathematics; it's flexible and can be used anywhere. These talents also enhance someone's general mental functioning by promoting critical thinking, pattern recognition and the ability to bridge seemingly unrelated ideas. Mathematicians, too: whether they are solving problems at work studying in school or just going about their business of life itself, good mathematicians can help solve society's welter of knotty (hard to untie) problems and make valuable contributions.

Pehkonen et al. (2013) argue that instructional strategies must be developed to accommodate the requirements of constructivism in particular, and increasing demands for learning across a changing world more generally. Teaching practices and methods must be changed to incorporate all aspects of 21st-century learning, based on constructivism. For instance, the Irish government in 1999 suggested that students of her schools design their internal structure. As a result, educators the world over have agreed that students must construct their knowledge; to be relevant information should be something students can use. This capability to solve mathematical problems is important because otherwise, people would not be able to excel in various academic fields or the real world. Problem-solving abilities consist of analytical and critical thinking. These abilities will benefit students in many ways, particularly when it comes to decision-making. Thus, students who are good at solving problems can reason in several practical contexts (Osman et al., 2018). Knowing the difficulties problem-solving involves, mathematics teaches students how to use what they've learned. It not only helps them understand but also encourages their minds to create and get into action thereby paving the way for better application of knowledge. Solving mathematical problems can be an effective means of promoting critical thinking and helping education, as mathematics is one aspect in the sense that it involves particular problem-solving methods for different kinds of questions (Moussavi

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1998; Osman et al., 2016). Thus people must have powerful mathematical skills in solving problems and an effective toolbox to handle the obstacles, make wise judgments and actively participate in innovation. We need those things now more than ever; since today's rapidly changing world brings us new types of challenges each day that require swift responses from everyone.

Studies have been made into the effectiveness of mathematical problem-solving techniques. An example is Osman et al. (2018), which used the Bar Model to examine students' ability to solve mathematical problems and found a large difference among participants' performance levels. Analyzing the semi-structured interview transcripts revealed that students 'performance was influenced by their level of comprehension and motivation. Furthermore, their results revealed that the application of Math's Bar Model boosted students' ability to solve mathematical riddles. The growth and variations in mathematics problem-solving abilities were analyzed by Kamila & Tabor (2023) using a cross-sectional approach to the differences in demographic background factors. It turns out that the students participating in this study were of average ability at solving mathematical problems. It was also found that when employing mathematical problem-solving techniques, the girls were superior to their male classmates and students from urban schools outstripped those of rural areas. Meanwhile, Haddad & Kalaani (2015) found that intervening early in computational thought boosted retention and progression rates as well as graduation of for STEM fields-related academic areas. Xiaoxuan, Davy, Wing and Manwai (2023) found students receiving the CT exercises on fractions in their fraction lessons wrote that they were able to better understand concepts about fractions from doing these kinds of CT skills (concepts associated with practices and views). Leveraging elements of fraction learning and adopting CT education in applications to primary mathematics classrooms, Strickland et al (2021) developed lessons on several concepts of CT like sequence, repetition and conditionals using scratch. According to the results, the experiment course improved students' understanding of fractions and programming language applications.

CT ability is widely applicable in various aspects of learning and critical problem-solving. There are plenty of examples which prove the significance (Wing, 2006; Barr & Stephenson, 2011). This particular synergy between CT and Mathematical Problem-Solving boosts problem-solving abilities in both fields (Diane & Leonard, 2022). Components of computational thinking include determining patterns, breaking down complicated problems into smaller pieces that are easier to resolve and creating algorithms for effective solutions (Gulbahar & Kukul 2016; Vassallo & Busuttil, 2022; Atmatzidou & Demetriadis, 2016), The main objective of mathematical problem solving, like this example, is to use mathematics and logical reasoning together with systematized procedures (Osman et al., 2018). Bringing CT into mathematical problem-solving brings a computational outlook. Then people use technology and algorithms to understand, judge or solve mathematical problems more effectively. This combination encourages people to think algorithmically about math, which enables them to come up with systematic answers and fosters a deeper understanding of mathematical concepts.

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In addition, the introduction of CT into mathematical problem solving is in line with technology becoming more and more important across many fields. It indicates how both mathematics as a professional knowledge base and human potential to wield computational implements should be broadly prepared for application within our changing technological environment. Teachers integrate computational thinking components into the mathematics curriculum, enabling students to develop a broad assortment of problem-solving abilities both founded on mathematical concepts and able to fulfil the needs for computing in today's digital era. Nevertheless, a review of the literature suggests that understanding CT about secondary school mathematics teaching is still insufficient. In Nigerian secondary schools, one of the limitations found is that there has been little research on how incorporating computational thinking affects students 'ability to solve mathematics problems. To plug these gaps, this study looks into how senior secondary school students in Akure South Local Government area of Ondo State, Nigeria solve mathematical problems when computational thinking is integrated.

Theoretical Framework

A thorough grasp of the research environment requires integrating several underlying educational and cognitive theories. However, this study is based on three specific theories. First, this study is grounded in constructivist theories. These believe that students actively produce knowledge through their activities and experiences. The foundation of this mathematics curriculum is constructivism. Based on these principles, children must develop their internal framework to understand mathematics. It follows that by applying the elements of computational thinking to mathematical problem-solving tasks; students can get some practical experience and make further progress in their level of understanding. In addition, the sociocultural theory underlying this study stresses that social interchange and joint construction of knowledge are essential to the educational process. Thus, the principles of computational thinking combined with mathematical problem solving will provide collaborative environments for answering questions. In these, students can talk and exchange ideas freely and create answers together.

The social and cultural elements in the education role of this paradigm are examined, including how the collaborative nature involved in integrating computational thinking affects mathematical problem-solving skills. Moreover, the study employs aspects of Gardner's theory on multiple intelligences which holds that different children have differing kinds and levels of cognitive abilities. Thus, to accommodate these different forms of intelligence, the study combined computational thinking with mathematical problem-solving. Students were thus exposed to various points of entry into understanding mathematics.

This theoretical framework not only serves as a conceptualization of the research, it also guides our study on precisely how incorporating computational thinking into senior secondary mathematics can develop an array of mathematical problem-solving skills for students with different learning styles and varying cognitive abilities. In sum, the theoretical framework of this study adopts a multi-perspective approach to research design and data collection as well as analysis to establish an adequate basis for investigating how computer science education can affect senior secondary students 'ability to solve mathematical problems.

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METHODOLOGY

To determine the relationship, this study adopted a quasi-experimental approach (Campbell & Stanley 1970). It used the pretested nonrandomized control group design. This was decided to be a suitable design because it would allow for the random assignment of research participants to groups in such a way that this doesn't interfere with the educational setting. The study sought to determine how teaching mathematical problem-solving skills by computational thinking at senior secondary school would influence academic results. To achieve this aim, the participating students were divided into two groups: experimental intact and control intact. To measure the effect that each of these independent variables exerts on students' academic accomplishment (the dependent variable), the researchers developed an instrument, the Posttest Mathematics Accomplishment Test (PMAT). The methods of instruction used in this study were the independent variables.

The design is illustrated graphically in the table below:

Table 1: The graphical illustration of the design

Grouping	Pre – Test	Research Condition	Posttest	Post – Posttest
Group 1: Experimental	O_1	Computational Thinking Principles	O_2	O_5
Group 2: Control	O_3	Control	O_4	O_6

There were 210 intact students in the study sample, with 105 people each representing experimental and control groups. The participants were divided at random into experimental and control groups. There were 125 female and 85 male participants in the study. Using a purposive selection, five schools were chosen for the study. To reduce the effects of experimental contamination, selection criteria were also applied in choosing SSS2 for use in the experiment (Dania, 2014).

The following criteria were used:

1) the schools were owned by the state government;
2) schools had at least two professionally qualified mathematics teachers with at least five years of classroom experience;
3) schools were coeducational;
4) Schools were accepting students for the Senior Secondary School Certificate Examination (SSSCE) in the sciences.

The work schedule and instructional materials used for this study comprised the instructional package. Using the mathematics textbooks approved for use in all senior secondary schools II (SSII) in Ondo State, the various subject objectives covered under the given subtopics for the students were ascertained. The package was prepared weekly. The package includes an overview of the lesson plan, details on its duration, behavioural objectives, students' activities, and teaching methodology.

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The package's draft was reviewed by three experienced secondary school mathematics teachers who were also experienced WAEC/SSCE/NECO examiners. These instructors were requested to:

1) Determine if the learning objectives are relevant to the contents to be learned by evaluating them.
2) Evaluate how well each topic's achievement examination reflects the lesson's goals.

Based on these instructors' suggestions, the objectives and accomplishment tests were changed to better-fit classroom use.

The topics taught during the study are:

1) Solution to complex algebraic equations
2) Sequences and series
3) Finding the greatest common divisor (GCD) of two numbers
4) Sort a list of numbers in a particular order (ascending and descending order)
5) Solving a system of linear equations

One of the instruments used in this study was a Pre-treatment Mathematics Achievement Test (PTMAT). This Test was given to every student at both Experimental and Control schools. It represented an attempt to determine whether or not homogeneity had been achieved between teaching groups before they started instruction. These are the ten questions, which deal with all the key topics necessary to understanding what was to be learned in this course. After treatment, the two groups were given the Post-test Mathematics Accomplishment Test (PMAT). The test was given right after the treatment was completed to measure how much the students who participated in this experiment learned and whether there were any discernable differences between performances on either side. The achievement test contained forty multiple-choice, objective questions. The test consisted of two sections: A and B. Questions on students' personal information appear in section A; while Section B consists of 40 objective, multiple-choice questions. Therefore, the foundation for writing an item was a test plan that showed how those specified objectives actually could be achieved. This test functioned both as an indicator of retentive capacity for the two groups. The retentive test took place two weeks after the post-test. Accordingly, two instruments were used to collect data for the pre-test and post-test. The test had a total score of 100 points which implies that each item received a score of 2.5.

The validity of the tools was verified through various procedures involving the evaluation of their content and how accurately they represent what they're supposed to measure. To make sure that the experiment was successfully communicated, the questions were written clearly, and were comprehensive, covering all of the topics that were explored during the experiment. The test questions were based on the standards laid by the National and West African Councils of Examinations. This is just what I assume as the test items are reliable.

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The pre-and post-test data was analyzed using version 23 of the Statistical Package for Social Sciences (SPSS). The hypotheses were tested by student's t statistical testing, while the study research questions topics received descriptive statistics analysis in terms of mean and standard deviation. For each hypothesis test, an alpha threshold of 0.05 was used.

RESULTS AND DISCUSSION

Four (4) research questions were proposed, and descriptive answers were given. For the study, we tested those four (4) hypotheses using a 0.05 threshold and interpreted them with appropriate inferential statistics. The sections that follow deal with the questions and hypotheses of the research.

Descriptive Analysis

Research Question 1: Is there any difference between the mean performance scores of students taught Mathematical Problem-Solving Skills utilizing the Computational Thinking principles and conventional method in pre- and post-test?

Table 2: showing the difference in the mean performance scores of students taught Mathematical Problem-Solving Skills using Computational Thinking principles and conventional method in post-test and posttest

	Pretest			Posttest		
Method	**No (%)**	**Mean**	**SD**	**No (%)**	**Mean**	**SD**
Computational Thinking principles	105(50.00)	7.56	1.94	105(50.00)	40.00	12.16
Conventional Method	105(50.00)	7.37	1.70	105(50.00)	34.00	11.04

Table 2 Average pre-test Performance scores in Mathematical Problem Solving Skills for students who received instruction using both the Traditional approach and Computational Thinking approach. According to the pretest, the Average score and standard deviation of those who received instruction using the Computational Thinking method were 7.56; the Standard deviation was 1.94. Moreover, the average pre-test score of students who were taught by tradition was 7.37 and its standard deviation was 1.70 a relatively small figure (0.19) is the mean difference between the two experimental groups. This demonstrated the homogeneity of classifications.

Average, standard deviation of post-test mean performance scores for students instructed in Mathematical Problem-Solving Skills with both traditional methods and those incorporating conceptual ideas from Computational Thinking In their post-test results, students taught using the Computational Thinking principles method came up with a mean score of 40.0 and standard deviation of 12.16 on average. Besides, students who were taught by the traditional approach had a post-test mean and standard deviation of 30.00 and 11.64 respectively. Thus, the two experimental groups differed by a mean of 10. Hence, students who were taught computational thinking performed better than those instructed conventionally.

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Research Question 2: Is there any difference between the mean performance ratings between students who learnt Mathematical Problem-Solving Skills using conventional and Computational Thinking methods?

Table 3: showing the difference in the mean performance score of students taught Mathematical Problem-Solving Skills using Computational Thinking Principles and conventional method

Method	No (%)	Mean	SD
Computational Thinking Principles	105 (50.00)	40.00	12.16
Conventional Method	105 (50.00)	34.00	11.04

Table 3 presents the mean and standard deviation of average performance scores regarding computer concepts students taught using conventional or experimental methods. But as our evidence shows, students taught using the principles of Computational Thinking performed better--average performance scores were 40.0 with a standard deviation of 12.16; those taught utilizing traditional methods earned an average score of 34. This indicates, therefore, that on average the experimental group's students performed better than traditional groups. Consequently, the group that was taught using Computational Thinking turned in better results than those who learned traditionally.

Research Question 3: Is there any difference in the mean performance score of male and female students who were taught Mathematical Problem-Solving Skills using the Computational Thinking principles?

Table 4: showing the difference in the mean performance score of male and female students taught scientific concepts using Computational Thinking principles

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Computational Thinking Process (Pre-test)	Male	40	14.81	1.424	0.225
	Female	65	15.50	2.345	0.291
Computational Thinking Process (Post-test)	Male	40	52.38	17.56	2.776
	Female	65	47.77	12.43	1.542

Table 4 shows the average performance score of those male and female students who were taught according to the Computational Thinking process method. The data showed that, though the mean difference (0.69) was a bit lower than in Cronbach's study because of slightly larger sample sizes on both pretests and post-equivalent tests here, female students scored a hair higher beforehand on average (15. 5 versus 14.8 for male).

In addition, in terms of the post-test results that are most important here, boys had an average score of 52.38 and a standard deviation (variability) was 17.56; girls scored an average of 47.77 with a standard deviation size for boys the table also demonstrated girls this showed a mean difference of 4.61.

The experiment indicates that, following the test, male students did better than females but only slightly. This means that in all probability male students were ahead of female ones but female students would still be able to hold their own against the males if they were taught using Computational Thinking approach.

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Research Question 4: Is there any difference in the capacity to remember knowledge between students taught Mathematical Problem-Solving Skills utilizing the Computational Thinking principles and those taught the traditional way?

Table 5: showing the retentive ability of students taught using Computational thinking principles and those taught using conventional method

	Group	No (%)	Mean	SD
Post-test	Computational Thinking Principles	105 (50.00)	57.00	14.62
	Conventional Method	105 (50.00)	38.00	13.14

As Table 5 shows there was a difference of 19.0 between the students taught with Computational Thinking Principles (57.0) and those without them (38.0). As a result, it appears that students using the Computational Thinking Principles technique were better at remembering information than those who used traditional techniques.

Hypotheses Testing

Hypothesis 1: There is no significant difference between the mean performance scores of students who were taught Mathematical Problem-Solving Skills using the Computational Thinking principles and Conventional method in the Pre-test.

Table 6: showing t-test analysis of the mean performance scores of students taught Mathematical Problem-Solving Skills utilizing Computational thinking principles and conventional method in the pre-test.

Method	N	Mean	SD	Df	$t_{(cal)}$	$t_{(tab)}$	Decision
Computational Thinking Principles	105	7.56	1.94	208	0.53	1.96	NS
Conventional	105	7.37	1.70				

$P<0.05$ level of significance NS = Not Significant

According to data from Table 6, The mean for respondents whose mathematical problem-solving abilities were taught through computational thinking (7.56) is higher than the corresponding figure of those who developed their skills more traditionally, by an average score difference of just 0.19 points. The standard deviation provides a measure of variability differs by (0.24). At the 0.05 level of significance and according to the t-test analysis, this calculated value (0.53) is less than the table value for that kind of social relation (1.98). Put differently, there is seemingly no significant difference between their pre-test mean scores in mathematics for students taught computational thinking and traditional approaches. The null hypothesis is therefore accepted. This means that the level of prior knowledge in those mathematical skills where they were measured was not significantly different between respondents who had been taught using computational thinking and traditional methods.

Hypothesis 2: There is no significant difference in the mean performance scores of students who were taught Mathematical Problem-Solving Skills utilizing the Computational Thinking approach and those taught the same skills utilizing the conventional method.

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Table 7: showing t-test analysis of the mean performance scores of students taught Mathematical Problem-solving skills using Computation Thinking process and conventional method

Method	N	Mean	SD	Df	$t_{(cal)}$	$t_{(tab)}$	Decision
Computational Thinking Principles	105	40.00	12.16	208	3.21	1.98	S
Conventional	105	34.00	11.04				

P<0.05 level of significance   S = Significant

According to the data provided in Table 7, the mean score of people who learned mathematic problem-solving skills using computational thinking was 6.00 points higher than those who learned these skills through traditional methods. The calculation of standard deviation shows that there is a difference of about 1.12 units, indicating that the data points have many varying values. The results of the t-test analysis show that the calculated value (3.21) exceeds the critical value (1.98) at a significance level of 0.05. It seems that there is a clear gap between the mathematical scores of students who learn mathematically with Computational thinking and the conventional methods. Since the data doesn't fit the pattern described in the null hypothesis, it is not supported. This means that there's a huge difference in the understanding of math skills among the students taught using computational thinking and traditional methods.

Hypothesis 3: There is no significant difference in the mean performance scores of male and female students who were taught Mathematical Problem-Solving Skills utilizing the Computational Thinking principles.

Table 8: is showing t-test analysis of the mean performance scores of male and female students taught Mathematical Problem-Solving Skills utilizing the Computational thinking principles.

Gender	N	Mean	SD	Df	$t_{(cal)}$	$t_{(tab)}$	Decision
Male	40	52.38	17.56	208	1.48	1.98	NS
Female	65	47.77	12.43				

P<0.05 level of significance   S = Significant

Table 8 shows that the mean distinction between the implied overall performance ratings of the male respondents (52.38) and the female respondents (47.77) is 4.61. There is a distinction of (5.13) within the well-known deviation, a degree of unpredictability. The calculated value (1. 48) is smaller than the table value (1.98) at the 0.05 level of significance, consistent with the t-test evaluation. It may be inferred from this that there was little distinction within the common performance ratings among male and female mathematics secondary school students who had been taught using the principles of computational thinking. Thus, the null hypothesis is maintained. This demonstrates that once teaching mathematical problem-solving skills is through the usage of Computational Thinking, female students can efficiently compete with their male counterparts. Consequently, there may be no manner to aid the null hypothesis.

Hypothesis 4: There is no significant difference in the retentive ability of students who were taught Mathematical Problem-Solving Skills utilizing the Computational Thinking principles

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and those taught the same skills utilizing the conventional approach.

Table 9: showing the t-test analysis of the retentive ability of students taught mathematical problem-solving skills computational thinking process and those taught the same skills utilizing using conventional method

Retentiveness	N	Mean	SD	Df	$t_{(cal)}$	$t_{(tab)}$	Decision
Computational Thinking Principles	105	57.00	14.62	208	6.16	1.98	S
Conventional	105	38.00	13.13				

P<0.05 level of significance S = Significant

The average difference between the two groups' retention scores is significant according to Table 9, with a mean difference of 19.00. The standard deviation, which is an indicator of variability, displays a significant difference of (1.49). The t-test shows that the observed value of 6.16 is greater than the critical value of 1.98 at 0.05. This indicates that the students who learned in the computational thinking process had different memories than the ones who used the traditional method. The students who learnt through the computational thinking method showed better memory retention and comprehension than students from the traditional teaching approach. Therefore, the hypothesis is rejected.

DISCUSSION OF FINDINGS

The descriptive results show that there were no differences between students learning mathematical problem-solving skills through computational thinking or the traditional teaching method after the initial evaluation. It was found that the students who were taught through computational thinking performed better than those who were taught through the regular way during the second phase of evaluation. The study showed that boys performed better than girls in learning mathematics problems by using the Computational Thinking technique, although the difference was not much. The researchers found out that the experimental students were able to solve mathematical problems better than the regular students.

The mean performance scores of mathematics students taught using the Computational Thinking process method and those taught using traditional approaches differ significantly, as indicated by the study's inferential analysis.

This is because students in the group that used the computational thinking approach performed better than those in the traditional group. Ultimately, their mean score rating was greater than that of the students who were instructed using the conventional method. This is corroborated with the findings of Strickland et al. (2021), Wing (2006), Osman et al. (2028), Kamila & Tabor (2023), Barr & Stephenson (2011), and Diane& Leonard (2022) that there was a positive and significant relationship between computational thinking and mathematical problem-solving abilities. This result is line with the finding of Xiaoxuan, Davy, Wing, and Manwai (2023), who discovered that students exhibited positive feedback regarding to the understanding of fraction concepts and the benefits of a particular set of CT skills (concepts, practices, and viewpoints) for the CT exercises that were integrated with fraction lessons.

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Also, the study revealed that there was no significant difference between the academic performance of male and female students who were taught mathematical problem-solving techniques using computational thinking process method. This implies that female students can compete favorably with their male counterparts if the Computational Thinking approach is used as an instruction which was at variance with the findings of Opolot-Okurut (2015), who discovered that while teaching students computational thinking, male students often outperformed female students. This result also at variance with that of Kamila & Tabor (2023), who discovered that Female students performed better than male students in a test measuring their ability to solve mathematical problems. However, the findings of this study vividly showed that Computational Thinking principles can assists students in learning new skills for a longer period and effect improve their performance on mathematical problem-solving. This finding is in consonance with an investigation conducted by Haddad & Kalaani (2015), which found that early computational thinking intervention increased retention, progression, and graduation rates in STEM-related areas.

CONCLUSION

The study vividly showed that students who used computational thinking methods in their mathematical problem-solving techniques performed far better than those who used traditional methodology approaches. Therefore, the study suggested that students who adopt computational thinking skills through mathematical studies can rate higher in their retention ability. The result of this study revealed that when students used a computational thinking approach to solve math problems, female students exhibited equal performance as their male counterparts.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations were made:

1. The application of Computational Thinking Principles in secondary school mathematics instruction is recommended since it facilitates students' efficient acquisition and retention of Mathematical Problem-Solving Skills.
2. Mathematics teachers in secondary schools should make sure that their presentations are structured to provide equal learning chances for male and female pupils to deliver lessons effectively.
3. Nigerian students can be well equipped to handle future job requirements if computational thinking is incorporated into their secondary school mathematics education. Policymakers need to ensure that this aspect is included in the overall school policy
4. Teachers of science and mathematics should emphasize the use of Computational Thinking concepts in their lessons more; to improve student performance in these subjects.
5. It is a good idea for schools to organize seminars for math and science teachers so that they can better incorporate computational thinking techniques into their lessons and enhance

their teaching abilities. This way teacher can help students get more chances of success in higher education as well as in their professional life. This can help them to stay current with the latest teaching practices and improve the learning experience of pupils.

6. The support from government, professional bodies, and associations is vital to the adoption of computational thinking in Science, Mathematics, and Engineering subjects. The creation of resource centres will help to provide better support and resources to educators, parents and students by making computational thinking-related information more accessible.

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